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THE ALLAHABAD AGRICULTURAL CONFERENCE.

By W. H. MORELAND, B.A., LL.B., C.I.E., I.C.S.,

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THE Agricultural Conference which was held at Allahabad in connection with the recent Exhibition was something of a novelty, so far at least as the United Provinces are concerned. Its object was to bring together a large and representative body of land-holders, and to direct their attention firstly to the more important problems presented by the agriculture of the province: and, secondly, to the solutions or attempted solutions of some of those problems which could be seen at the Exhibition. The general idea was that the mornings should be devoted to discussion, while the afternoons were occupied by special demonstrations illustrating the subjects that had been considered in the morning.

A conference on these lines requires a certain amount of preparation, and it may interest officers in other provinces to know the lines on which it was organised. The first question that arose was the issue of invitations: it was recognised that, while a large proportion of these must necessarily be issued by the department, others must be issued by independent agencies if the Conference was to be really representative and not open to the reproach that it consisted merely of a few friends of the department. Accordingly the invitations fell into two classes,—those selected by the department and those placed at the disposal of other bodies.

The first class included, firstly, the members of the Legislative Council and the principal title-holders of the province, invitations to whom were as a matter of courtesy issued by the Local Government: secondly, a large number of officials, includ-

ing the officers of all the agricultural departments in India, and the managers employed by the provincial Court of Wards; thirdly, those non-official gentlemen who are directly connected with the department, including the governors of the agricultural college and the honorary visitors to the various agricultural stations; fourthly, the representatives of exhibitors in the Agricultural Court; and lastly, a large number of gentlemen who are accustomed to co-operate with the department in various matters. The second class included the nominees of the Upper India Chamber of Commerce, of the various agricultural associations and of the district exhibition committees.

The results of this selection were on the whole highly satisfactory. The bulk of the Conference consisted of country gentlemen, not over-anxious to mount the platform but ready to listen to what was said and to study the demonstrations from a very practical standpoint.

The selection of subjects was a matter of some difficulty. It was recognised that the attention of the audience must be concentrated on particular points, and the number of points on which discussion appeared to be desirable was so large as to render the choice embarrassing. The course adopted was to assign each day to one or two main subjects, and to select three or four aspects of these subjects for detailed discussion. Then two or three speakers, chosen for their special knowledge of the subject, were invited beforehand to contribute the opening papers of each discussion; and following on their papers other speakers were invited from the audience, each speaker being limited to five minutes. With these arrangements, the discussions proceeded on the whole in a satisfactory manner: some nonsense was talked but that was inevitable, and succeeding speakers were usually quick to detect it.

The Conference opened on the 13th January 1911, when Sir John Hewett, the Lieutenant-Governor, took the chair and gave a brief address, in which he laid stress on the necessity that agriculture should move with the times and adapt itself to new conditions. His Honour then vacated the

chair, which (in the unavoidable absence of Mr. Leslie Porter, the Senior Member of the Board of Revenue) was occupied by Mr. Brownrigg, the Commissioner of Allahabad. The remainder of the session was devoted to discussing questions of administrative importance, the relations of the department with the people, the organisation of the people so as to obtain the full benefit of the department's activity, and the creation of the profession of estate agent. It fell to the present writer to introduce each subject in turn: the most noteworthy papers were those contributed by Mr. Hose, the Chief Secretary to Government, on agricultural associations, and by Mr. Pim, Joint Secretary to the Board of Revenue, on the training of estate agents; but valuable contributions were also made by Sir Tasadduk Rasul Khan and Rai Sri Ram Bahadur, two representatives of the Talukdars of Oudh. The speakers who offered themselves at this session had not in some cases grasped the division of subjects, but their remarks were, as a rule, valuable in showing the public recognition of the work of the department and the general desire for an extension of its activities.

The main subjects for discussion on the second day were wheat and cotton, and the chair was appropriately taken by Sir Alexander McRobert, a leading representative of the business interests of Cawnpore. The discussion on wheat was opened by Mr. Albert Howard, the Imperial Economic Botanist, who gave a popular account of his work at Pusa and indicated that more and better wheat could be grown in North India than is now the case. He was followed by Rai Nathi Mal Bahadur, a prominent representative of Indian commerce; and the subsequent discussion brought out clearly the general opinion as to the superiority of Muzaffarnagar wheat to the varieties grown in other parts of the provinces.

The attention of the Conference was then directed by Dr. Parr, the Deputy Director of Agriculture in charge of the Western Circle, to the possibilities of obtaining an increased yield from the indigenous cottons: and he was followed by Mr Bevis, a partner in the well-known Elgin Mills, who urged

the importance of increased production. After the discussion on this subject had closed, Mr. Shakespear called attention to the utilisation of cotton seed, and indicated the conclusions to be drawn from the experimental cotton-seed-oil factory which his firm was conducting on behalf of Government. No serious difficulty had been found in the technical processes; the oil was readily marketable from the start, and the market for cake was beginning to develop on satisfactory lines.

The third session of the Conference was devoted to co-operation, the chair being taken by Mr. D. C. Baillie, Member of the Board of Revenue. This discussion was marked by the contributions from men of practical experience in organising and managing co-operative societies: thus Rai Ishar Sahai Bahadur described his successful work in Fatehpur; Mr. A. C. Mukerji gave his experience as Manager of the Kashi (Benares) Co-operative Bank, and Mr. A. H. C. Hamilton described the working of the Prayag (Allahabad) urban society. Interesting papers were also contributed by Munshi Kabul Ahmed (Sandila), Munshi Ganga Prasad (Mainpuri) and Rai Kali Charan Sahib (Unao); and the general discussion showed the extent to which the co-operative movement has already won appreciation among the people.

An afternoon session was devoted to entomological questions, the chair being taken by Mr. Coventry, the Officiating Inspector-General of Agriculture in India. Mr. Fletcher, the Supernumerary Entomologist, Pusa, gave an interesting lecture on insect pests, referring specifically to the sugar-cane grass-hopper and the potato moth, two pests which are very active in the province at the present time. The lecture was followed by a brief discussion on the suitability to the province of the *Eri* silk industry.

The fourth day of the Conference was devoted to questions affecting the sugar industry, Dr. Leather, the Imperial Agricultural Chemist, being in the chair. The first subject was improvements in cultivation: Mr. Clarke, the provincial Agricultural Chemist, described some of his preliminary results

showing the great differences in the value of different varieties, the possibility of economising seed-canes, and the importance of proper manuring. This subject attracted few speakers, and the Conference turned to consider the question of making *gur* suitable for refining into sugar. Mr. McGlashan of the Cawnpore Sugar Works, read an instructive paper in which he explained the drawbacks incident to refining from ordinary *gur*, and also the difficulties which the cultivator would have to face in changing his practices. After a short discussion on the subject, the indigenous system of sugar-making was considered and roused considerable interest. Mr. Dickinson, who represented Messrs. Broadbent of Huddersfield at the Exhibition, opened the subject by explaining the advantages to be derived from the introduction of the centrifugal: and then Rai Ragho Prasad Narain Singh Bahadur advocated from personal experience the adoption of the Hadi processes of sugar-manufacture, which were also recommended by Mr. Sealy of Gorakhpur, Pandit Durshan Lal Dube of Rewah, B. Janki Prasad of Fatehpur-Sikri and B. Pheku Ram of Jaunpur, all of whom have experience of working these processes. On the other hand, representatives from Bareilly, one of the chief centres of the industry, criticised these processes from the commercial side, and Mr. Allen, the Collector of Bareilly, expressed the opinion that there was not much to choose between the Hadi processes and those worked in Bareilly, but that the introduction of the centrifugal was an undoubted improvement for work on a fairly large scale. Mr. Hadi replied to the criticisms which had been offered on his processes, and a most interesting discussion was then brought to a close.

The Conference then considered the introduction of small modern factories. Mr. Hulme, the Engineer in charge of the Exhibition factory, described the processes carried on in it, emphasising the fact that with the exception of quicklime no chemicals of any sort were used. His paper produced little discussion, but the crowd of visitors at the factory on this and subsequent afternoons showed the interest which it had aroused.

The fifth day was devoted to the consideration of implements and machinery, Mr. McLeod, the Chief Engineer to Government, being in the chair. The discussions were introduced by the present writer who pointed to the progressive rise in wages as being a factor of fundamental importance in determining the future of agriculture. Mr. Milligan, Deputy Director of Agriculture, followed with a paper indicating the effect of high wages in the Punjab, and the consequent development of the use of machinery: and after remarks by various speakers, Mr. Burt, the Deputy Director in charge of the Agricultural Court of the Exhibition, gave an account of the different classes of implements that were shown, and described a mechanical installation recently set up by a land-holder near Cawnpore who, beginning with an oil-engine and pump, had added a flour mill, cotton gins, a small grinding mill and a chaff-cutter.

The subject of water-lifts was then introduced by Mr. Chatterton, Superintendent of Industrial Education, Madras, who described the progress made in introducing pumping-plants in Southern India. A discussion followed on the difficulties in bringing implements into general use, which brought out very clearly the need for simplicity in construction and for the provision of facilities for repairs. Following on this Mr. Molony, Commissioner of Gorakhpur, read a paper on wells in which he explained the different ways in which Government was prepared to assist construction: and the session closed with a paper by Nawab Fateh Ali Khan Kazilbash, describing the advantages he had secured by having his wells bored.

The closing session of the Conference was devoted to questions relating to cattle, and the chair was occupied by Rai Sundar Lal Bahadur, one of the most prominent citizens of Allahabad. The discussion on the first subject, the protection of cattle from contagious disease, was characterised by cordial appreciation of the work of the Civil Veterinary Department; while that on cattle-breeding brought out little beyond the needs, already recognised, for more grazing and better bulls.

The question of providing dairies for the cities of the provinces attracted wider interest as the high price of *ghi* is the subject of general complaint. Mr. Smith, the Military Dairy Expert, urged that legislation to prevent adulteration was a necessary step; and it may be mentioned here that the chairman of the day has since introduced a Bill dealing with this subject in the provincial Legislative Council. B. Moti Chand of Benares urged that the dairy industry was particularly suited to private enterprise: and Mr. Chatterton suggested that the supply of milk could be simplified by the use of milk-powder, a special demonstration of which was given in the afternoon. The discussion had eventually to be closed owing to want of time, and the Conference then broke up after the chairman had thanked its organisers and suggested that similar conferences should be held periodically in different centres of the province.

The question may be raised: was the Conference worth the trouble? An answer to this question must not be looked for merely in the proceedings;* the success of the Conference is to be judged by its effect on the large majority of the members who took no active part in the proceedings, and that effect is not likely to manifest itself immediately. But judging from the enquiries made during and after the Conference, the effect has been considerable; a large number of intelligent men are now thinking over the agricultural problems of the localities in which they live, and seeking the help of the department in applying the solutions which they heard of at the Conference; and it is not, I think, too much to say that the whole current of public opinion has been concentrated and directed on more definite lines. And so far as the department is concerned, the Conference has been of very real value in bringing the officers into closer touch with many of the natural pioneers of agricultural development, and in enabling them to realise more clearly than before the attitude of the people and the nature of their needs for assistance.

* The proceedings have been printed by the Superintendent of the Government Press at Allahabad and will shortly be on sale.

RURAL ECONOMY IN THE BOMBAY-DECCAN.—III.

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(Continued from page 123 of Vol. VI, Part II.)

VI.—Live-Stock.

The live-stock of the Deccan consists of the following:—

Horses and ponies	...	...	71,000
Sheep	...	...	... 1,300,000
Goats	...	...	... 1,200,000
Buffaloes	...	...	... 500,000
Cattle	...	...	... 2,900,000

Before considering each class separately it will be desirable to give some idea of the general conditions under which stock is bred and reared in the Deccan. On the crest of the ghats, and in the strip of country adjoining, the rainfall is very heavy during the monsoon. This results in an abundance of grass; but it is coarse and of a poor feeding value; while, in this tract, the climate during the three months of excessive rain is prejudicial to the health of stock. The East Deccan is a dry country and grazing is very scanty. All the good land is cultivated, and, though large areas are available for grazing, they consist almost exclusively of stony uplands where the soil is of the thinnest. On such lands herbage is scanty and is confined to the rainy months—July to October. In an ordinary year the cattle have to work hard to find a living on these hills after December; and from March to July the so-called grazing grounds are, for the most part, as bare as a high road. In the intermediate tract between the ghat region and the East Deccan there is a fair

rainfall, and in some localities the facilities for grazing are much better. Here and there considerable areas of occupied land lie uncultivated, and the natural herbage provides some grazing; but no attempt is made to improve or enclose them, and it is only by courtesy, that they can be called pastures. Stock, during the greater part of the year, are expected to pick up a living as best they can on the hills, in the river beds, or in weedy fields from which the crop has been harvested.

Ponies are bred principally in the Eastern Deccan. In the old days Deccan ponies had a considerable reputation, and gave the mobility for which the Mahratta armies were famous a century and a half ago. Even at the present day the Deccan ponies are extremely hardy and enduring, and do good work in tongas; but their virtues end there. They are, for the most part, under-fed and under-sized; and their appearance usually indicates that they have been worked too young. The Army Remount Department has demonstrated at Ahmednagar that, with care and expenditure, good horses can be bred in the Deccan; and private breeders are not slow to avail themselves of the services of the stallions maintained by Government in the Deccan for their use. Here and there a well-to do landholder will make a hobby of high class horse-breeding, and occasionally breed a really good foal, and obtain a good price for him; but it is hardly business, and is not usually regarded as such. If anyone requires a good horse or pony, he knows that his best chance is to go down to Bombay and buy an imported Arab or Waler.

Goats are found in every village. The males are killed for food and the females provide milk for children. No trouble is taken with their breeding; but they are very hardy, and shift for themselves, costing practically nothing to their owners for food. Under these circumstances they may be considered as a source of profit to the latter; but in so far as the community is concerned, it may be doubted whether they do not cause more loss than gain; for they roam over the unfenced country browsing on any crop that is not strictly guarded and making tree

growth impossible in places where it would otherwise take place.

Sheep are grazed in large herds of 100 to 300, and are generally accompanied by a few goats. Many shepherds lead a migratory life, frequenting the dry uplands of the Eastern Deccan during the wet months, and afterwards bringing their flocks down to the cultivated lands, where the farmers welcome them after the crop is removed, for the sake of the manure which they provide. The sheep are kept constantly on the move, and thrive on the scanty herbage, though they do not get fat on it. No system of fattening is practised, but wethers of one year old afford lean mutton which seems to satisfy the meat-eating classes who know no better. It is probable, however, that judicious fattening would pay round the larger meat-eating centres. The wool is wretchedly poor, but the manure brings in some profit, particularly in a locality where sugar-cane and other valuable garden crops are grown.

The peculiar conditions under which the sheep industry is carried on may be gathered from the following figures supplied by a sheep owner in the east of Poona District.

ANNUAL ESTIMATE FOR A FLOCK OF 100 EWES.

Profit.

	Rs.
Fee paid to owner for folding 100 sheep by night on garden land on account of manurial value, at the rate of 5 annas a night for 100 sheep, for 9 months of the fine weather	84
During the remaining three months they are folded in a yard and the manure for the period may be taken as worth Rs. 16	16
Total value of manure ...	100

	Rs.
Two shearings of wool a year worth 4 annas a sheep, or Rs. 25 per 100 ...	25
100 ewes will give 100 lambs a year, 50 male and 50 female. Allowing 20 per cent. for wastage this leaves 40 one year old wethers for the butcher at Rs. 3-4-0 each	130
40 cast ewes for the butcher at Re. 1-8 each	60
Total ...	190

Profit (abstract).

	Rs.
Manure	... 100
Wool	... 25
Sale to butcher	... 190
Total	... 315

Cost

	Rs.
Feeding costs practically nothing but 2 annas a head grazing fee to Government	... 13
Miscellaneous	... 8
Wages of one man and one boy at Rs. 12 per mensem for the two	.. 144
Total	... 165

Net profit (Rs. 315 minus Rs. 165)=Rs. 150.

So that if the capital value of each ewe be taken at Rs. 3, the sheep owner makes 50 per cent. on his capital. If the size of the flock be 300 instead of 100, the cost of labour for herding is proportionately cheaper, and the net profit is larger. On the other hand, in the wetter localities of the West Deccan the losses from disease are greater and the profits are correspondingly less.

Cattle form by far the most important and valuable part of the live-stock of the Deccan. Taking the term Deccan as denoting the Central Division of the Bombay Presidency, the number of cattle amounts to $3\frac{1}{2}$ million, of which about one-sixth are buffaloes. Of the buffaloes the large majority are milch buffaloes. Except near a few large towns the milk supply is in no sense an organised industry. In the case of these towns the milk supply is derived mainly from buffaloes: but the Deccani buffalo is not a good milk breed, nor does the country provide the quantity or quality of fodder requisite for effective milk production. The price of good milk in towns is usually very high: and much of the milk supplied is heavily adulterated. Much might be done to improve the supply of milk; and no doubt there is money to be made in the business;

but the conditions of the country make it a difficult and precarious one. In the case of a few of the better breeds of cattle, when the object is to breed good bullocks, the calf is allowed to run with the cow and the cow is not milked; but in most cases the calf is allowed to suck only one half or one quarter of the milk, according as it is a bull or a cow calf.

The importance of cattle is far smaller from the point of view of milk supply than from the point of view of draught. As regards draught the horses of this tract are of little importance. Buffaloes are used in small numbers for heavy draught, for ploughing in rice fields and in some localities as the first pair in a large team of plough animals. But it is the oxen who do almost all the ploughing and other field operations in the Deccan on which the agriculture depends. The plough cattle amount to 1,315,000 and the plough buffaloes to 55,000. A large proportion of the plough cattle, including most of the best, are imported into the Deccan from Central India,* and command high prices. Eighty years ago a good working bullock of the small local breed could be purchased for Rs. 20; even 10 or 15 years ago it could be purchased for Rs. 30; but in the last 10 years the price has doubled, and is steadily rising. A fairly good Deccani bullock now costs about Rs. 60, a half bred Khillari, Rs. 100 or more, while a good Khillari or Krishna valley bullock may fetch anything up to Rs. 300 or even Rs. 400.

The cause of the rise in price is not far to seek. Ninety years ago cultivation in the Deccan generally, and in the East Deccan in particular, was scanty, and there were large areas of good land which lay waste and grew some kind of herbage. The demand for cattle was then relatively small, and the waste lands provided grazing grounds which enabled cultivators to rear cattle sufficient to meet the demand. With the advent of more settled conditions, however, a large increase of cultivation occurred, and reduced the area of grazing grounds. This process steadily continued till towards the end of the last century; at the

* The term Central India is here used as including the Central Provinces.

present time, practically all the good land is occupied, and most of it is cultivated. During this time, as the demand for bullocks increased, large numbers were brought for sale from the extensive grazing grounds of Central India: and the result of this change in economic conditions did not at once become obvious. It was not till the famines of 1897 and 1899-1900 that the pinch was severely felt. After recovering from the famine of 1876 the cattle in the Deccan had remained fairly steady at 3,700,000 during a series of good years in the eighties, and during the early nineties rose to 4,000,000. Then came the famines of 1896-97 and 1899-1900 during each of which nearly a million cattle were lost; so that in spite of purchases from outside the number fell from over 4 millions in 1895 to less than two and a half millions in 1901, a fall of two-fifths in the aggregate, and of over half in the case of certain districts. The plough cattle which numbered 1,631,000 at their high water-mark in 1895 had lost one-third of their number by 1901, and have only made up half of this loss ten years later, their number now standing at 1,371,000. It might have been expected that cattle would pour into the Deccan from Central India to make up the deficiency: and no doubt considerable numbers did come in. But Central India also had suffered severely from famine, and though prices rose, the supply fell off. The acreage of cultivated land in the Deccan amounts to 13,635,000 acres; which gives almost exactly one pair of bullocks to 20 acres. Now it may be roughly taken that in the Deccan a pair of good bullocks can cultivate 30 acres of light soil, 20 acres of medium soil and 10 acres of heavy black soil. Assuming that the cultivated area is equally divided into these three classes the present number of plough cattle works out at almost exactly the required number, *viz.*, a pair for each 20 acres of land. There are, however, two considerations which greatly discount this apparent sufficiency of plough cattle. In the first place, a large number of them are engaged for a great part of the year working the *mhots* on the 156,000 irrigation wells, and many more are employed for most of the fair season in carting on the roads; while the 500,000 acres under irrigation demand a

higher degree of cultivation, and require more bullocks. In the second place, the assumption that the plough cattle are all efficient is far from being a fact. It may be said without fear of exaggeration that 20 per cent. of the so-called plough cattle are practically useless and that another 10 per cent. are very ineffective. It is not possible to make more than a rough estimate of the number of cattle that is necessary, but the following may give some idea of actual requirements :—

	Bullocks.
To cultivate 13½ million acres	1,350,000
Allowance for working wells	100,000
Allowance of extra bullocks for irrigated lands ...	50,000
Total good bullocks necessary ...	1,500,000

Assuming that 25 per cent. of the total number of bullocks are useless, it will need a total of 2,000,000 to give 1,500,000 effective work oxen : and this may be taken as a general indication of the number necessary. The allowance made for extra bullocks for irrigated land is very moderate ; and the allowance for work on wells has been pitched very low, since most of this work is taken as being done by ordinary plough bullocks ; while no extra allowance is made on the ground that many of the cattle are used for a large part of the year in carting. It will be seen that, according to this estimate the number of work cattle has never been adequate, and is now 31 per cent. short. But the estimate made may be taken as a moderate one ; and as irrigation increases the number of work cattle necessary will rise. The deficiency can be remedied either by increasing the numbers or by improving the quality of the animals. In either case the question of fodder is at the root of the matter. Even during a series of good years the number was unable to rise higher than 1,650,000 bullocks, good, bad and indifferent : which was itself insufficient ; and a few bad years reduced the number to 1,100,000 which is totally inadequate. To provide against such losses the storage of fodder in good years to tide the cattle over the bad years is essential. Much might be done in many parts to make better use of the existing fodder supply ; but that in itself would

not suffice. The people must adapt themselves to the new conditions and realise the imperative necessity for growing fodder crops. It may be said that there is hardly any lesson that they have to learn more important than the growing, efficient storage and economical use of fodder crops.

In the case of improving the quality of the cattle, too, the question is primarily one of fodder. In many localities the supply of stored fodder is barely sufficient for the working animals, and the cows and young stock are turned out all the year to shift for themselves. The nature of the grazing grounds has already been described, but the hardy stock get along fairly well from August to February. From March onwards their state is very miserable. They rapidly lose condition, and are driven by hunger to eat almost any refuse, and even to gnaw the trees. By July they are reduced to skeletons; and when the rain commences, and the young grass begins to grow, they gorge themselves on it, and suffer severely from scouring and tympanitis. Under such conditions good bullocks cannot be reared, and it is not much use talking of careful breeding. Where the fodder supply is better, some care is taken in the matter of mating. In such cases the object is usually to provide a good bull of the Khillari breed to run with the village herd. The idea is to grade up the small Deccani breed, and to rear stock of the size and strength necessary for ploughing the stiff black soils. It is generally believed that the Deccani breed has greatly deteriorated in the past 50 years. Be that as it may, it is certain that cattle larger and stronger than the present ones are required for effective ploughing; and with rising prices and a falling supply from outside the only way that the cultivators can get them is to breed them themselves. In England over half the farm land, exclusive of mountain, consists of permanent pasture, and of the arable a large part is devoted to fodder crops. To one accustomed to this state of affairs it seems natural to suppose that the Deccan cultivator would recognise the direction in which lies his only remedy. But from time immemorial he has been accustomed to trust to the waste lands for the main support of his stock.

and he still sighs for the extensive grazing lands of the past, which have assuredly gone, never to return.

Much emphasis has been laid on the question of fodder as the prime factor in the case. It will be realised, however, that there are other considerations of importance. Three great obstacles to progress consist of the constant recurrence of contagious cattle disease, the neglect of the cultivator to castrate the young bulls that are unsuitable for breeding, and the impossibility of eliminating the unfit owing to the religious objections of Hindus to kill cattle. Losses from contagious disease are trifling as compared with losses from starvation; but from 1,000 to 10,000 deaths from the former cause are reported every year; and the real numbers are probably far greater. It is not so long since such diseases were rife in England. In 1865-66 the losses in England from rinderpest were estimated at 234,000 animals, worth from five to eight million pounds sterling. The stringent sanitary measures which are there enforced by law have completely stamped out the worst of these diseases. The nature of these measures is well known, and it will suffice to say that in the case of rinderpest the owner of diseased cattle is bound to give information, and the local authorities are bound to take prompt action. All affected animals and all animals which have been in the same stable, shed or herd or in contact with affected animals *must* be slaughtered, and other animals about which there is any suspicion may be slaughtered if the Board of Agriculture think fit. No animals may move out of an infected area, or from one part to another of an infected area. Fairs and markets are prohibited. Carcases are properly disposed of; and care is taken to prevent the importation of disease from abroad. Apart from the question of slaughtering cattle, such regulations would in India be regarded as intolerable; and it would be impossible to enforce them. But in England where they have been strictly enforced, the value to the farmer of the results that have been obtained is incalculable. In India the lines of work indicated are preventive inoculation and the segregation of diseased animals.

The neglect of the Deccani farmer to castrate all young bulls not required for breeding makes careful mating impossible in a country where all the cattle run together. The excellence of the Kankreji breed in Upper Gujarat and Kathiawar is mainly due to the fact that the breeders of those parts practise early castration. In the Deccan they do not castrate bulls till they are four years old, and the number of unsuitable young bulls which run with the herd cannot fail to have a bad effect on the breed.

A matter of more importance to the present enquiry is the case of the 25 per cent. of useless cattle of all kinds, amounting in round numbers to 900,000 beasts. These consist of worn-out old bullocks, barren cows, and beasts which from extremely stunted size, malformation, broken limbs or bad feet are useless for work purposes. In a meat-eating country all such animals would be promptly fattened off and sent to the butcher, and so become a source of profit rather than loss. But in India the demand for beef is very limited ; so most of them continue to eke out a wretched existence. In this connection it may be worth while to consider the statement which is frequently made that the slaughter of cattle is in a great measure responsible for the deficiency of work-cattle. The argument seems to be that a certain number of cattle exist, and that if you kill some the number left must of necessity be less. It ignores the nature of the cattle slaughtered, and the fact that the number of existing cattle is not a fixed quantity but, within broad limits, can be increased at will. The reasoning is in fact very similar to that which underlies the theory of the "drain of wealth" from India. Now with regard to the slaughter of cattle in the Deccan the facts are these. About 50,000 cattle are annually slaughtered in the Deccan or drawn from the Deccan for slaughter in Bombay. These consist almost exclusively of worn-out old bullocks, lame and malformed beasts and barren cows. Not 5 per cent. of those slaughtered are, or could ever, become of any use either for draught or for breeding purposes. To ascertain this all that is necessary is a visit to the slaughter-houses ; but an examination of prices will suffice

to show that this must be so. The carcass of an average Deccani bullock of the kind and condition brought to the slaughter-house, skinned and dressed, weighs about 150 lbs, which at the current rate of 12 lbs. per rupee is worth Rs. 12-8-0. The hide is worth Rs. 6 and the offal and fat (say) Re. 1-8-0. Total Rs. 20. But between the cultivator and the meat seller are several middlemen who have to make their profit, and recoup the cost of bringing the animal to market. The cultivator will be lucky if he gets Rs. 15 for the bullock. Now it has already been stated that the price of a good Deccani bullock is Rs. 50 to 60; and it may be confidently stated that there is not a bullock of any use for draught that would not command at least Rs. 30. Is a cultivator likely to sell to a butcher for Rs. 15 a bullock which will command Rs. 30 or more in the market? He certainly will not do so; and if he sells a bullock for Rs. 15 or less, the reason is that it is useless for draught purposes, and its only value is for slaughter. The same argument applies to a bullock of larger breed, with a dead weight of 300 lbs.: all that is necessary is to double the figures, and it will in the same way be realised that a cultivator will not sell to a butcher for Rs. 30 a bullock for which he could get Rs. 60 or more for draught purposes. So far as bullocks are concerned, a consideration of the price of beef and the price of draught animals will show that a draught animal is worth far more alive than dead. Under such circumstances it is only the unfit and the worn-out that are brought for slaughter. Occasionally a calf may be seen at the slaughter house which looks as though it would with proper attention turn into a fair bullock and one wonders why the cultivator has sold it. It is pretty certain, however, that the original owner knew more about the calf than the casual observer does, and he also knew what facilities he had for rearing the calf to maturity. If he found it more profitable to sell it for Rs. 10 when it was young and in fair condition, he probably knew what he was about. Barren cows provide the best beef; and are often young and in good condition when brought for slaughter. They are of course useless for any other purpose.

The number of cows wholly or partially barren to be seen round the country side is very remarkable. Anyone accustomed to the circumstances of economic cattle-farming expects to see every cow earning her living. She should be in milk, or in calf, or fattening. But in the Deccan numbers of cows are to be seen doing nothing to pay their way. Many are completely barren, and many others calve only once in two or three years, and give but little milk, and that for a short time only. This is partly a matter of personal idiosyncrasy, and partly due to lack of green fodder without which cows will not come in season. In some cases a little work would probably put the cows right: but this is contrary to Hindu custom. In France and Belgium small holders habitually work the cows. They generally cannot afford to keep bullocks, and in such cases the cows have to do all the cultivation. Far from being bad for the cows, light work is beneficial to their health even when they are in milk. They must, of course, not be given very heavy work or be put to a severe strain: but when carefully treated by the owner they do useful work without any harm to themselves: and in this way they are of the greatest assistance to small holders.

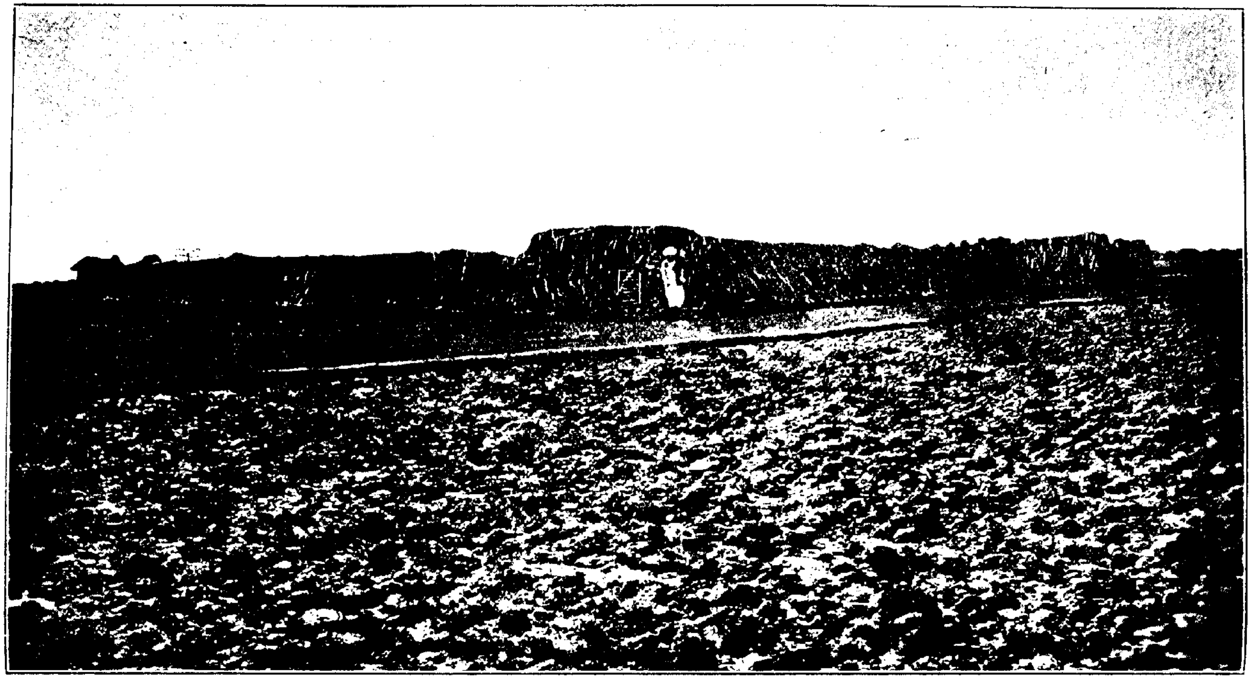
It will be realised from the above that it is not the 50,000 Deccani cattle which are slaughtered annually which cause loss to the cultivator, but the 800,000 useless beasts who are not slaughtered. If there was a greater demand for beef and the cultivator could dispose of them all for slaughter even at Rs. 10 a piece, the Deccan would be Rs. 80 lakhs better off, and there would be more grass for the effective cattle to eat.

In stating the economic facts with regard to the slaughter of animals, it must not be supposed that it is intended to recommend to Hindus that they should countenance the slaughter of cattle. It would be obviously improper and foolish to advise them to do what is repugnant to their religion and to their feelings. It is essential, however, to realise the facts. In India the provision and maintenance of cattle are a source of difficulty and loss to the cultivator, while in other countries the cattle are a source of profit. Leaving on one side England, where cattle are

not used for draught, and looking at France over a large part of which cattle do most of the farm work, it is found to pay to slaughter bullocks not only when they are getting old, but long before they are worn out. Bullocks are commonly worked from 4 to 7 years old, and then fattened off. Fine bullocks of the large white Charolais breed may be seen going off to the butcher at the age of 7. It is simply a question of what pays best; and it is by such methods that cattle which used to be regarded as a "necessary evil" to the French farmer are now converted into a source of profit. The French farmer sells off his seven years old bullock to the butcher knowing that he has more young ones coming on. He takes three years work out of them and converts them into cash before they begin to deteriorate. It is not likely that the demand for beef in India will increase to a point at which the flesh of all useless animals would find a market, and it is, therefore, most improbable that the price of beef will rise to a point at which it would pay to slaughter animals which are of any value for draught or for breeding. The above facts are, however, mentioned to show that even if such a thing were to occur, it would not necessarily be prejudicial to agriculture. Far from it: it would solve the greatest difficulty of the cultivator, and enable him to do what the French farmer has done, *viz.*, to make the meat consumer pay for the ploughing of his lands.

(*To be continued.*)

PLATE XXVI.



Wall Enclosed Vineyard.

GRAPE-GROWING AROUND PESHAWAR.

By W. ROBERTSON BROWN,

Superintendent of Farms, N.-W. F. Province.

THE grape vine is vigorous and fruitful throughout the greater part of the North-West Frontier Province. A grape *pergola* is generally to be found in the public garden of each district and the shade tree by the well of the zamindar is often vine-embowered. But vineyards in the true sense of the word are chiefly clustered around villages which have grown grapes for the Peshawar market for at least half a century. The villages of Ahmad Khel, Bazid Khel, Sheikh Mohammadi, Suleman Khel, and a few others in the Peshawar tahsil, which are situated within eight miles of Peshawar city, have long been noted for the productiveness of their vineyards and the quality of their grapes.

The village of Sheikh Mohammadi has 400 vineyards; Suleman Khel has 100; Mashu Khel has 150; Bad Ber has probably 100, and other villages in the same tahsil have each from 20 to 100 vineyards enclosed by walls and ranging from one quarter to two acres in extent. Each of these villages markets many hundreds of maunds of grapes in the months of July and August. Plate XXVI shows the unpicturesque walls of a typical vineyard. The stalwart Mohmand viticulturist creeps in and out by the little wicker gate which is 4 feet high by 2 feet wide.

Climate and Soil. The temperature within the walled-in vineyards throughout the year has not yet been recorded, but in July and August, with the faintest breeze shut out, the atmosphere in the vineyard is stifling. Even under the dense canopy of foliage the temperature is probably not less than 130° at noon. In December and January it ranges from 22° to 80°. In average

years heavy showers of rain fall in February, and again in late March or early April. Then follow two or three months of fierce unbroken sunshine, during which time the vineyards are freely irrigated. These are exactly the conditions under which superb European hot-house grapes are produced. The vineries there are sprayed freely while the young shoots are extending, but after the berries are set, spraying is discontinued as it would blemish the berries. The land around the grape-growing villages is renowned in the North-West Frontier Province for its fertility. It is deep red alluvial loam and is fertilised by the heavy deposits of muddy silt which the water of the Bara leaves after every turn of irrigation.

Drainage and Irrigation.—The vineyards have excellent natural drainage, and around the villages the land is levelled for irrigation on contour lines, scarcely two fields being on the same level. The Bara water rises and falls rapidly. Its bed is not infrequently almost dry for a considerable time and then the vineyards, in common with field crops, suffer from drought. As far as possible, the vine growers irrigate every tenth day between 15th April and 15th June. After the crop is gathered, irrigation in moderation is renewed till early December, after which the vines are given three months' rest. The high mud-walls serve to protect the vineyards from scorching winds, from grazing animals and other depredators. Thefts by the villagers are rare, for the owners of the vineyards give generously, and the poorest can afford to buy a few peaches or grapes in the season in July or August.

Preparation of the Land and Planting.—After the protective walls are built in December, the land is ploughed as frequently as possible before the 15th January. In early February wide shallow irrigation channels are dug out at 15 feet from centre to centre and usually 4 feet wide by one foot in depth. Cuttings—not rooted nursery plants—are planted. Sites are marked down the middle of each irrigation channel, and four stout vine cuttings, 1 foot of which is buried, are set at each site. One foot of cane is buried. When planting is finished, the groups of cuttings are in squares which are exactly 15 feet

apart every way. White ants invariably eat one or two of the cuttings, and it is on this account that four cuttings are planted. Two plants only are desired at each site. In the first year brinjals, or other summer vegetables, are grown between the newly planted vines, and the shoots from the cuttings are permitted to ramble at will over the catch crops.

First Pruning.—In February, almost exactly twelve months after the date of planting, the first pruning and shaping of the vines begin. Strong canes are *slightly* cut back; weaker canes are more severely shortened. In each cane the laterals (shoots from the leading canes) are cut back to one or two buds from their bases. When the vineyard has been dug over by the spade, light twiggy branches, like pea sticks, and about 2 feet to 3 feet in height, are stuck irregularly over the land, and chiefly around the plants. Over these the young shoots of the year are allowed to grow unchecked. By the 15th of June, when the plants are 16 months of age, the vineyard presents a broad level spread of luxuriant deep green foliage. Each vine is now vigorous and in unchecked state of growth.

Second Pruning. Next year second pruning and the cropping begin. Most of the work of cultivation in the vineyards is done in February. At that time the vines are pruned and the land is turned over by the spade. Pruning in the first and second years is light work. In the third year the tangled masses of shoots are cut back to the main rods. Each vine has from three to five *arms* or rods of 8 to 12 feet in length. The laterals on the rods are pruned annually to within half an inch of their bases. The pruning given in this, the third year, is exactly that which is practised throughout the lives of the vines. Grapes are borne on shoots of the current year only. The vigour of the vines is by the pruning confined to comparatively few shoots, and these are in consequence strong and capable of maturing good bunches of grapes. The *datrie*, a small saw toothed sickle, is used as a pruning knife. European gardeners would recoil from this barbarous treatment. The real work of training the vines begins after the second pruning. A rough framework

of any available branches is erected over the vineyard at about $2\frac{1}{2}$ to 3 feet from the ground. The bare pruned canes are spread over and lightly tied to the frame. That completed, the vine grower can rest till his crop is ripe. The young shoots which spring from the pruned canes are not summer pinched or checked in any way. They grow widely in every direction.

Cropping.—A few bunches of grapes are carried by the vines in their third year; but full crops are borne from the 7th year. There is a fruitful vineyard at Bazid Khel which has carried good crops of grapes for over 50 years. The Peshawar tahsil vineyards are mostly of mature age. The number of bunches per vine is not regulated. Every bunch is permitted to remain; nor are the berries in the bunches ever thinned. Under this inconsiderate treatment the weight of crop per vine varies annually. Some vines carry thirty bunches, others carry over one hundred.

Varieties.—Seven distinct varieties are grown and the oldest villagers say that all of these were in the old vineyards of their forefathers. The varieties are described on page 225 from a grower's point of view. (Plates XXVIII & XXIX.)

Harvesting and Marketing.—In gathering fruits the labourers have to crawl on hands and knees. It is trying labour, and a boy from a grape growing village would not willingly gather grapes between 9 A.M. and 6 P.M. The grape growers commonly lease the crops of their vineyards to Peshawar fruit agents for periods ranging from two to ten years. The owners cultivate the vineyard, dig, prune, and weed; they maintain the vineyard walls and they pay the land revenue. When the crops are ripe, the agents take over charge, and market the grapes. The sum received by the growers per half acre (*jarib*) varies considerably. If a vineyard has a good proportion of vigorous vines of kismis, bedana or sursavai, Rs. 400 may be realised. Rs. 200 per *jarib* per annum is considered a poor price. The villages of the Peshawar tahsil have an unusually amiable and convenient arrangement for the supply of the Peshawar market. Each village or pair of villages has two allotted market days per week

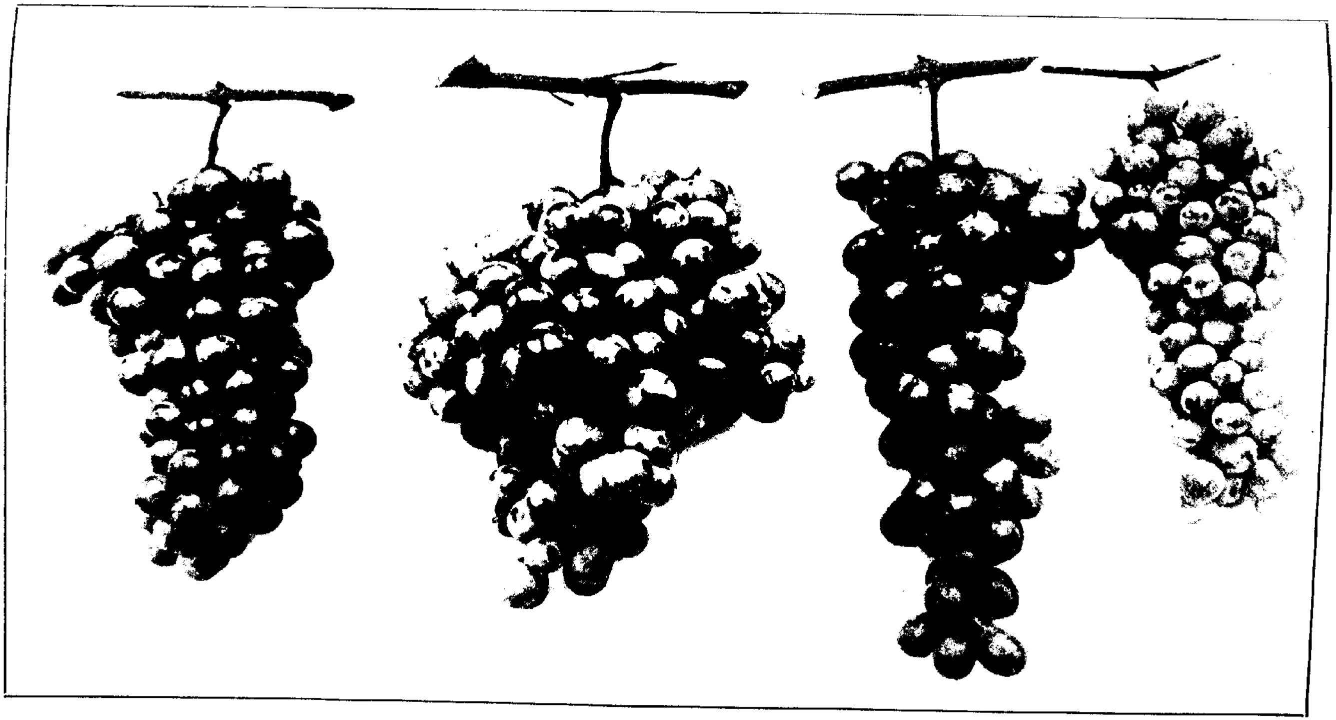


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PLATE XXVIII.

TUR.

TAS.

KISHMISHI.

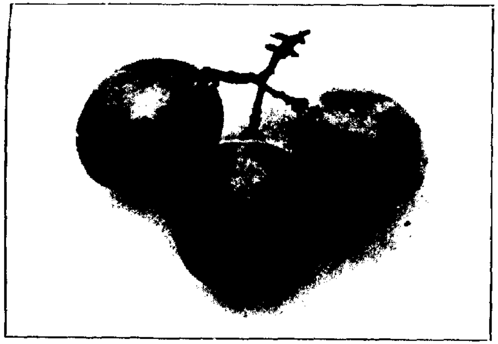
Peshawar Grapes in their order of ripening.

Variety.	Vigour.	Leaves.	Bunches: Size.	Bunches: Shape.	Bunches: Setting.	Berries: Colour.	Berries: Shape and size.	Berries: Skin and flesh.	Berries: Flavour.	Cropping.	Price per maund.
											Rs. Rs.
1. [illegible]	[illegible]	Large and [illegible]	Medium [illegible] large.	Shouldered	[illegible]	[illegible]	Round, medium.	Thick, fairly firm.	Good	Very heavy	5 to 8
2. [illegible]	Weak	[illegible] and flat.	[illegible]	Without shoulders.	[illegible]	White	[illegible] oval, small.	Very thin, fairly firm.	Very good, excellent.	Very light	10 to 25
3. [illegible]	[illegible]	Large and thick.	Very [illegible]	Shouldered	[illegible]	Greenish white	Round, medium.	Very thick, very firm.	Poor	Fair	2 to 10
4. [illegible]	Do.	Medium	Medium to large.	Without shoulders.	Good	Reddish purple	Oval, large	Medium, watery.	Excellent	Heavy	3 to 8
5. [illegible]	Weak	Small, thin and round.	Small to large.	Do.	Do.	White	Round, medium.	Thin, firm and seedless.	Do.	Light	5 to 20
6. [illegible]	Do.	Large and thin.	Small, [illegible] large.	Do.	Moderate	Do.	Do.	Thin, fairly firm.	Fair	Poor	2 to 8
7. [illegible]	Moderate	Medium, thin and yellowish.	Medium to large.	Do.	Do.	Do.	Oval, large	Thick, watery.	Do.	Light	6 to 10

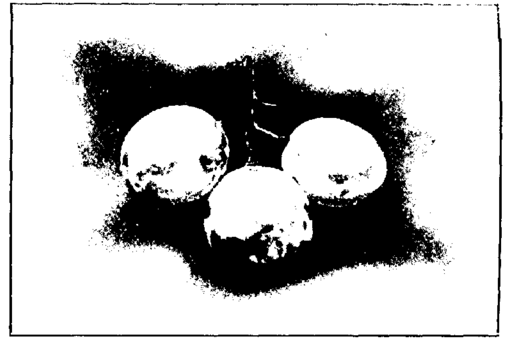
One may market on Monday and Thursday; the other on Tuesday and Friday, and so on. In this way village inter-competition is avoided, and the market is less likely to be glutted. The fruit is cut in the evening, and piled lightly on large open flat baskets which carry from 20 seers to 1 maund. Scarce or delicate kinds, such as kismis or bedana, are marketed in baskets which carry 20 seers or less. The fruit is conveyed to the city market on flat hand-carts drawn by two stout men. Round cockle-shell shaped baskets are used in conveying grapes by rail to the more important cities and towns of Northern India. The baskets are lined with soft dry grass and a few vine leaves, and when packed weigh 10 seers. The bunches are evenly and firmly packed and convex lids are laced securely down. Railing is entirely in the hands of the fruit agents. They book orders and arrange for supply.

Diseases and Insect Pests.—The pests of the vineyards of the North-West Frontier Province have not yet been studied, but it may safely be said that most of the troubles which affect European or American grape vines trouble the grapes of the North-West Frontier Province to some extent. Phylloxera is happily not known. Mildews are common; there are few large bunches of grapes which have not a proportion of "shanked" berries—or "scalded" or "rusted" berries. Red spider spreads every autumn. Thrips and aphides are not serious pests.

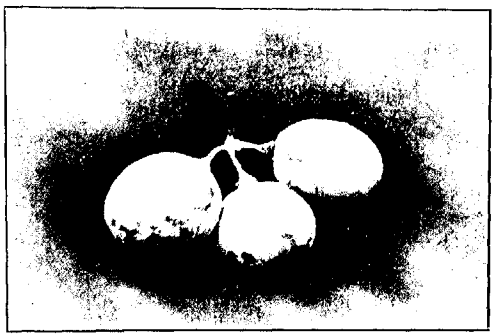
PLATE XXIX.



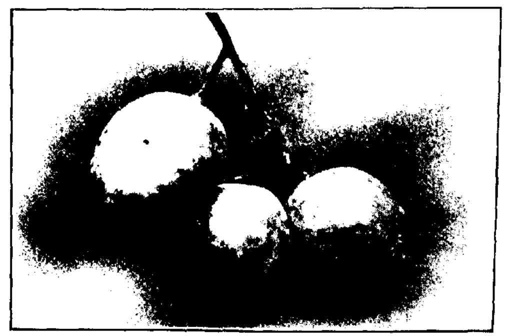
SURSAVAL.



BEDANA.



A. J. I. JOSHI.



HUSSAINI.

PLATE XXX.

GENERAL VIEW, AGRICULTURAL COURT.

THE AGRICULTURAL SECTION AT THE ALLAHABAD EXHIBITION, 1911.

I.—MACHINERY AND IMPLEMENTS.

By S. MILLIGAN, M.A., B.Sc.,

Deputy Director of Agriculture, Punjab

THIS section of the exhibition has been the subject of many laudatory reviews, and, on the other hand, of not a little adverse criticism, the main objection offered being that many of the exhibits were unsuited for use in India. This somewhat narrow view of the subject neglects the acknowledged educative value of exhibitions generally, and more especially in India, where the public have few opportunities of seeing what is being done in the outside world. To those interested in the agricultural development of this country the agricultural machinery section contained much of interest, and not a little of immediate practical value.

As it is quite impossible in a short article to deal with the whole exhibit in this section, it is proposed to refer briefly to a few of the more important classes, more especially with regard to their suitability to the conditions of Northern India.

The more obvious features of the Exhibition have been so fully described elsewhere that little remains to be added. Suffice it to say that the site was ideally chosen on the banks of the Jumna—the buildings were commodious and sufficient, and that the general arrangements left nothing to be desired (Plate XXX). A feature of the agricultural machinery section lay in the facilities for practical trials of tillage implements and such machinery as threshers, winnowers, mowers and reapers, provided

for by the Exhibition authorities: and although the available space was necessarily limited, these trials were of great assistance to the judging committee and of interest to visitors generally.

Tillage Implements.—In any country implements for tillage are of first class importance, and this is more especially the case in India. Experiments conducted by the Agricultural Departments have shown the great possibilities of increasing the yield of crops by improved methods. It is almost certain that this will only be brought about by improved implements, as the *rayat* has probably reached his limits with his present stock in trade. Dealing first with ploughs, it may be stated that this section showed great variety and was on the whole representative of the modern plough (Plate XXXI). For the sake of awarding prizes the exhibits were divided into three sections—heavy, medium and light.

Heavy Ploughs. In the heavy class, which included gang ploughs of both the disc and mould board patterns, the most interesting feature was, perhaps, the trial of a single reversible disc plough, shown by Ransome, Sims and Jefferies, Ipswich, which made short work of some stiff land with a fairly hard crust near the pumping station and suggested possibilities for dry land cultivation. Other exhibits in this class consisted of lea, stubble and furrowing ploughs, which though good in themselves presented no new departures in design.

Medium Weight Ploughs. In this class there was a large number of exhibits and the majority of the ploughs were included in it. On trial very satisfactory work was performed by ploughs exhibited by John Wallace and Sons, Glasgow; and Ransome, Sims and Jefferies. These two ploughs, which are of the same pattern, finally shared premier honours and were awarded gold medals. The pattern is very suitable for medium cultivation, cleaning out perennial weeds and, if properly used, for ploughing in green crops for manure.

Light Ploughs.—This class was meant to include all small ploughs costing under Rs. 10 to be used for general purposes as a substitute for native ploughs. Although exhibits were

PLATE XXXI.

Ploughing : Agricultural Court.

plentiful, they all belonged to the two types of plough well known in India as the "Watts" and "Meston" patterns. On trial the Watts had no difficulty in defeating its rival the Meston, and the final award went to Ransome, Sims and Jefferies for a well finished specimen of the former, which, considering that the share and other parts are made of chilled steel, should be good value for the money. Summarising, it may be stated that each class of the plough section produced one or two ploughs of considerable utility for special purposes in India.

Harrows and Cultivators. This section was none too good, considering its importance. There was a distinct want of variety in the exhibits, and with the possible exception of spring toothed harrows there seemed to be little of value for Indian requirements. Messrs. Ransome, Sims and Jefferies, it is true, showed a spring tined cultivator of great finish and quality, and one could only regret that it was too good for the country.

Intercultivating Implements.—In this class may be grouped both hand and bullock or horse hoes and harrows. The exhibits were of the pattern generally adopted now-a-days with multiple adjustments and presented no new features. This is an important class of implements for India, where intercultivation is so necessary to preserve moisture and keep the soil in proper condition during the early stages of the growth of the crops.

What is wanted for India in this class is more good patterns than first class workmanship. Soil conditions are, compared with most other countries, very easy, and it is not advisable for the cultivator to put his money into getting too high a finish in his implement. Harrows, cultivators and drill hoes, etc., can be, however, readily and cheaply made in the country—all that is necessary being correct patterns. It is hoped that the best types, shown at the Allahabad Exhibition, will supply this.

Harvesting Machinery.—Next in importance to tillage implements comes harvesting machinery. There is little doubt but that the prolongation of the wheat harvesting season affects the whole system of agriculture in the Punjab and parts of the United

Provinces, and severely handicaps any attempt to improve on present practices. It should, therefore, be remembered that the adoption of improved harvesting processes in addition to any direct benefits, would undoubtedly have a powerful indirect effect on the agriculture of these Provinces. To secure the introduction of machinery for this purpose, however, it must pay its own way initially, as the people are not at all inclined to look to indirect advantages.

Reapers and Mowers.—This class in the exhibition was of interest mainly on account of the fact that the scarcity of harvest labour in the Punjab has made reapers a very profitable investment on land where they can be used. In the greater part of Northern India their extended use is under present conditions out of the question. The number of exhibits were few. The gold medal was awarded to John Wallace and Sons for the type of machine which has been used in the Punjab for three years, and is an adapted mowing machine with manual delivery. The second prize went to the International Harvesting Co. for a McCormick side delivery machine.

Threshing Machines.—The necessity of improved threshing machinery for wheat is becoming more evident every year, and although many efforts have been made to solve the question, little headway has been made. It is hoped that the attention drawn to the subject by the Exhibition will have the effect of promoting the movement. The difficulty is entirely one of *Economics*, as the machines shown at Allahabad on the whole performed their work very satisfactorily. The crux of the question lies in recovering interest and depreciation charges on an expensive plant in the short season during which it can be used. The deciding factor in this class of machinery is thus the ratio of the output to capital cost. Hence, other things being equal, reliability and that which comes to the same thing in India, simplicity of design, are essential. In the Exhibition chief interest was, of course, centred in the steam threshing plants, which for a considerable time gave working demonstrations daily.

Steam Threshers.—Three English firms came forward with exhibits. Marshall Sons & Co. and Garretts with one plant each, while Ransome, Sims and Jefferies showed two of different designs. All machines were of the latest patterns approved by their makers, and there was really little to choose in the work done by them, which, as mentioned above, was quite satisfactory. All machines were fitted with straw bruising and chopping apparatus. At the same time it must be admitted that for ordinary purposes in this country three of the machines were of a type which presented too many complications. The fourth, shown by Ransome, Sims and Jefferies, a 30-inch machine driven by a 3 h.p. portable engine, came much nearer to what is required for the country. The machine in question, by effecting the chopping in the threshing drum, is thereby so much simplified that it presents the appearance of a large open sifter with two cylinders. Weight is also considerably reduced and the set, each part of which (the engine and thresher) weighs only 3 tons is quite portable even on district roads.

Bullock Power Threshers.—It was a pity that the machines exhibited in this class could not be shown working. There is little doubt but that a really satisfactory machine for bullock-power would command an immediate market. Both Messrs. McCartney, Old Cumnock, and the Bon Accord Co., Aberdeen, exhibited useful looking machines, but it is impossible to estimate their worth without trial. None of the exhibits had straw chopping and bruising attachments. It is a pity that no attempt had been made to exhibit anything in this line, as there is only one season for *bhusa* making in Northern India and the operation must be done at harvest time, when the straw is dry and brittle.

Hand Power Threshers. A few firms exhibited hand power threshers. Owing to the strain required to keep up speed there does not seem much opening for this class at present. A machine shown by Messrs. Hunt, which did good work on trial, might probably with advantage be driven by cattle.

Winnowing Machines. The people in Northern India depend entirely on the wind for winnowing purposes, and

although the dry climate is favourable for all harvesting operations, much time is lost in localities where wind is uncertain. Until steam threshing is successfully introduced, if it ever is, into these places, a winnowing machine for the threshed wheat crop is needed. This section in the Exhibition was, therefore, an important one, and although most machines shown were of the grain-dressing type, there were a few exhibits, which represented attempts to produce machines for Indian requirements. A machine exhibited through the Central Provinces Agricultural Department, manufactured in the country, deserves some mention. Made entirely of iron, it should be fit to stand any climate. The mixture of chaff and grain is shaken transversely over a rough riddle with a considerable slope, and provided the straw in the mixture is not too long, the machine does satisfactory work.

An entirely different type, built by John Wallace and Sons, for the longer and rougher *bhusa* of the Punjab, has long smooth perforated zinc riddles, a horizontal shake, and a blast divider. The whole machine is built to avoid choking and to give a large daily outturn. Its work was considered so good that a gold medal was awarded to the maker. Other machines, as stated above, were practically grain-dressers and though good in themselves, had little capacity for dealing with *bhusa*.

Having dealt with tillage implements and harvesting machinery, which are the main stock-in trade of farmers all the world over, and of which the largest portion of the agricultural machinery of the Exhibition consisted, there remain many additional features well worthy of mention.

Fibre-extracting Machinery. Fibre extracting machinery comes more under the head of Industry than Agriculture, but it is impossible not to note the excellence of the exhibits in this section. Special mention must be made of the decorticating machinery of Messrs. Krupp and Co., which specially commended itself to the judging committee after extended trials, and was one of the most attractive sights in the exhibition.

PLATE XXXII.

MACHINERY SHEDS, AGRICULTURAL COURT.

Bullock Power Cane Crushing Mills.—It is with real pleasure that we have to refer to the excellent exhibit of the Nahan Foundry in this section. This well-known factory, owned by the Nahan State (Ambala Dist.), has probably done more for sugar-cane growers in the Punjab by the great efficiency of its cane mills than any firm in existence. They exhibited a complete set of their standard pattern mills, which were models of good workmanship and careful adjustment.

Dairy Machinery.—The Dairy Industry in India is assuming an increasing importance, owing to the industrial development of the country and the demand for a better class of produce from the large towns. Although exhibitors of this class of machinery were few, the deficiency was more than made up by the completeness of the working dairy shown by the Dairy Supply Co. in conjunction with Mr. Keventer of Aligarh. The plant was thoroughly modern, driven by electricity and was the centre of much interest.

Space does not permit of mention of many other interesting features in the Agricultural Court. Such exhibits as fodder presses, flour mills, rice-husking machinery, all of which are of direct and indirect importance to a rural community, have not been dealt with. The necessity of explanatory remarks in an article of this nature necessarily limits the number of classes which can be discussed and also any detailed mention of the names of the exhibitors. The excellent general displays in the stalls of firms like Burn, Marshall, Ransome, Sims and Jefferies, Rudolph Sack, Krupp, Thomson, Leslie, The Empire Engineering Co., the International Harvesting Co., and many others can only be mentioned (Plate XXXII). After all that has been said of the excellence of the organisation of the Exhibition, it was the enterprise of the exhibitors which made it the undoubted success it was.

II.—WATER-LIFTS.

By ALFRED CHATTERTON, B.SC.,

Superintendent of Industrial Education, Madras.

In the report of the Irrigation Commission, which for statistical purposes is now perhaps a little out of date, it is stated that in the United Provinces there are 500,000 permanent wells and 830,000 temporary wells irrigating in a normal year 5,731,000 acres. The average lift is probably not less than 30 feet and in the aggregate the amount of work done by cattle power in lifting the water for the irrigation of this vast area is enormous and the cost to the ryots of the country an annual sum which may be more than, but certainly cannot be far short of, 10 crores of rupees. This is not all, as besides the area under wells, there is much irrigation under canals, *jheels* and swamps which involves lifting the water. It is true that the lift in these cases is seldom more than a few feet, but most of the work is done by hand and human labour is invariably more expensive than cattle power.

I do not pretend to any great accuracy in the above statements, which are only made to illustrate the importance of water lifting in these Provinces and the necessity for carrying out such work in the most economical manner possible. That it is not so done goes without saying, but the extent to which improvement is possible is quite unknown. It is a matter for the State to deal with as the problem is far too difficult for private individuals to tackle, and there is but little chance that any adequate solution would yield a direct pecuniary reward to the individuals who

worked it out. It is mainly a question of adapting the means available under modern conditions to the end required, which is the lifting of small volumes of water through a moderate vertical distance. If the volumes were larger or the vertical range greater, the problem would be a simpler one. The real element of difficulty is to apply mechanical methods of lifting water to the small scale on which the ryot works.

I am not sufficiently acquainted with the ryots' methods of lifting water in the North of India to express any opinion on the possibility of improving them, but in respect to the South of India I feel fairly confident in saying that the best practice of the ryots in their methods of applying animal or human power to lifting water is, if not perfect, exceedingly hard to improve upon. The *picottah* is a very efficient water-lift for heights ranging between 10 and 20 feet, and though at first sight it may seem that to employ one man solely to tilt the bucket and guide the lifting rod is a waste of energy, yet it is not really so, as by changing round from time to time each man gets a needed rest and the work goes on without exhausting the men for a longer time than would otherwise be the case. Similarly the South Indian *mhote* with its leather or iron bucket and leather discharge pipe is, when worked on a steep incline on the *Kili* system, an excellent method of utilizing cattle to draw water from a deep well. It of course involves the employment of two pairs of cattle and is not well adapted to shallow wells from which water may be drawn by the *mhote* worked on the *lagoe* plan with one pair of cattle. Various attempts have been made to improve on these methods and some of them have had a certain amount of vogue for a time, but they have gone out of use and must therefore be classed as failures. The indigenous methods are the result of long experience and are probably an example of the law of the survival of the fittest—that is, of the methods of drawing water from wells which are most suited to the environment and resources of the ryots. Experience has taught the people of India that, to get the most work out of men or animals, they must not apply their muscular efforts to the direct production of

external work, but that they must, as far as possible, store kinetic energy in their bodies, and utilize the same by allowing their weight to act by the descent of their bodies. The *picottah* has a high efficiency because this principle is very perfectly carried out in that water-lift and the single *mhote* has easily held its own against the double *mhote*, partly because of its simple character, but mainly because whilst descending a steep incline, the gradient of which is from 1 in $2\frac{1}{2}$ to 1 in 3, the animals automatically throw a very considerable proportion of their weight on to the yoke and thus are able to exert a much stronger draught than when walking on the level and therefore draw up a much larger bucket of water each time. Again, an animal like a bullock and still more a pair of them are able to exert a much stronger draught in a straight line than when walking in a circle. To attach a pair of animals to a gin or whim such as is very commonly used is to employ their muscular efforts in the most inefficient way possible. The smaller the diameter of the circular path in which they walk, the worse is the result. No ingenuity in the design of the water-lift worked in this way can altogether compensate for the defects in this system of employing power. In some instances, such as the common mortar mill, the cheapness and simplicity of the device compensates even for this defect, but in the case of water-lifts the possibility of using other and better methods of lifting water puts the gin out of court.

It is not unlikely that mechanical methods of lifting water will ultimately displace cattle power almost entirely, but that day is still far distant, and in the meantime it would be of great advantage to the agricultural community if authoritative and complete trials were made of the efficiency of the various indigenous methods of lifting water. Fifteen years ago with Mr. C. Benson, the then Deputy Director of Agriculture in Madras, I made some experiments in this direction which led me to the above conclusions, but it would be well if they could be repeated on a more extended scale and the relative merits of the different methods of applying power determined with greater accuracy than was possible with the limited opportunities we

then enjoyed for such experiments. Considering the enormous number of cattle power water-lifts at work in India, it seems to me that the interests involved will amply justify the trouble and expense of such investigation.

It is true that records exist of many tests of water-lifts, but unfortunately the results are of no comparative value as every observer failed to measure the strength of the cattle employed. A pair of bullocks is a vague term: one pair may be easily twice as strong as another and some way of comparing the strength of the animals must be devised. Failing any better method, I assumed that for animals and men in good working condition their strength was for each class proportionate to their weight and though this may not be strictly accurate, there is no question that it does to some extent serve as an indication of the amount of muscular energy which can be obtained. Here it may be convenient to state that I obtained a very useful co-efficient or figure of merit by dividing the useful work done in foot pounds per hour by the weight of the animals in pounds. My experiments led me to the conclusion that we were not likely to be able to effect any marked improvement in the indigenous methods of lifting water. The development of the internal combustion engine a few years later rendered it possible, however, to employ mechanical power in place of men or animals wherever the supply of water exceeded a certain quantity and opened out a new field for experiment and investigation. The American windmill also seemed worthy of trial and during the last nine years in Madras we have been working to adapt these entirely novel sources of power to the service of the ryot. With the windmills, we have not met with much success owing to the general feebleness of the air currents, but it has been otherwise with the oil engine coupled to a centrifugal pump, as is attested by the fact that there are about 300 installations of this character at work in the South of India. The main objection to the oil engine and centrifugal pump is that it can only be worked economically when the quantity of water to be dealt with is large. Nine thousand gallons per hour may be taken as the economic minimum

that the centrifugal pump can deal with and there should be enough water to keep the plant at work for about 6 hours per day. Any extension of these figures means increased economy, and the larger the unit that can be employed, the more satisfactory is the result. With sufficient water, the cost of lifting it is from one-fourth to one-tenth the cost of the older methods, and volumes can be dealt with and vertical lifts tackled that are absolutely beyond the range of cattle power. We are still only at the beginning of this revolution in lifting water for irrigation, and no one can doubt that as it extends, the increased experience will render it more efficient and more adaptable to the every-day needs of the smaller irrigators.

These preliminary remarks on the subject of lifting water are necessary to explain the standpoint from which the following notes have been written on the display of water-lifting machinery at the Allahabad Exhibition. As a spectacle, the show round the lake in the Agricultural section was impressive, but a detailed examination of the exhibits leads to the conclusion that the problem of lifting water for irrigation has not yet received the attention in the North of India which its importance deserves. The exhibits may be divided into three main classes, according to the source of motive power: (1) men, (2) cattle, (3) engines, and only in the third section was there anything like a complete representation of the available methods. Indigenous methods of lifting water were conspicuous by their absence, and it is a matter of regret that no attempt was made to show one specimen at least of each of the methods of lifting water commonly used in various parts of India. For instance, in Madras we have quite a number of water-lifts which seem to be unknown in the North of India, and under suitable conditions the introduction might be attended with advantage. I might cite as examples the various forms of double *mhote*, the *picottah* and the Malabar scoop wheel. Where so much was done, it is perhaps ungracious to ask for more, especially as the erection and exhibition of these lifts in working order would have entailed much trouble and not a little expense on the authorities in charge of the Agricultural section.

Of water-lifts to be worked by men there were a great variety of pumps actuated by levers, all better suited for garden work and occasional use than for steady employment day in and day out on the irrigation of field crops. The only device really intended for irrigation was the chain pump exhibited by the United Provinces Agricultural Department. For low lifts up to, say, 5 feet it is probably an effective device as the pump is very efficient, gives a continuous flow of water, and the only objection to it is the mode of application of the power which is extremely simple but very fatiguing. For lifts above 5 feet its utility is doubtful and at 15 feet it is only about half as effective as a *picottah*. From a circular on pumps issued by the Agricultural Department at Cawnpore I find it is stated that four men working 10 hours a day will lift 6,806 c. feet of water to a height of 15 feet in two days. Assuming that the men weigh an average of 120 lbs. each, I calculate that they will do 319,000 foot lbs. of work per hour, and this number divided by their total weight gives as a figure of merit or co-efficient of utility, 664. This may be compared with a trial I once made with a *picottah*. The lift was 14½ feet, and the three men employed weighed 331 lbs., and did 394,310 foot lbs. of useful work per hour—the co-efficient of utility being 1,191. The duration of the trial in this case was seven hours and the men worked in a normal way. This is by no means an unusually good result, and with an improved lift worked on the *picottah* principle, I have obtained co-efficients as high as 1,800. The chain pump is a very efficient water-lift, but the rotary method of driving it, though it has the advantage of being very simple, is not an effective method of applying human power. I doubt if it would be possible to satisfactorily arrange any system of treadles or levers to be moved by the weight of the operators, and such being the case, the advantageous application of the lift is limited to raising water a few feet.

In all the lifts worked by cattle the gin was used and the cattle walked in a circle about 20 feet in diameter. The gins were well and substantially made, but the rotating arm was too short except for small cattle, and a pair could only be effectively

employed by attaching one animal to each end of the rotating arm. This is unsatisfactory unless the animals can be trained to work without a driver to each of them. The gins were employed to drive chain pumps or *norias*. From data given in the circular of the Agricultural Department already referred to, it appears that the co-efficient of utility of a gin-driven chain pump works out at about 470, which is about as good a result as can be obtained with the single *mhote* worked on the *Kili* system and somewhat better than when they are worked on the *lagor* system. My practical experience with chain pumps and *norias* is too limited to justify me in expressing any opinion on their merits as water-lifts for ryots' use. I once made some experiments on a *noria* and obtained a co-efficient of utility of 404, and from measurements made on the draught exerted by the cattle I found that as a machine it had an efficiency of 50 per cent. For low lifts the chain pump is undoubtedly superior to the *noria*, but on lifts of over 20 feet I have no information as to their relative efficiency.

Besides the bullock-driven chain-pumps and *norias*, there was exhibited a double trough water-lift called a "Baldeo Balti." I quote from the Agricultural Department circular the following description: "It consists of two iron troughs, each having a valve at the bottom opening upwards. They are hinged on a beam fixed to the ground at discharging level and are alternately raised and lowered by ropes attached to the back ends of the troughs, passing over two pulleys and so to a horizontal beam pivoted at one end, which is pulled round by a single bullock walking in a circle." It is certainly a simple effective device for lifts of 3 or 4 feet, but its merits would be mainly determined by its efficiency and on that point I have no information. I am inclined to think it would be less efficient than a well-designed chain-pump.

It should be pointed out that chain pumps and *norias* are not suitable types of water-lift for wells in which the water level varies greatly. The load against which the power is exerted varies with the height to which the water has to be lifted, and

as the water goes down, the strain on the cattle increases. On a *noria* the load might be diminished by removing some of the buckets, but in practice this is not a convenient arrangement. Cattle working a gin walk at a uniform pace and exert a steady draught and to be employed in an effective manner the load must be steady and proportioned to the draught they can exert. Obviously this is impossible with chain pumps and *norias* if the water level varies. At the beginning of the day's work the load will be too light, or if properly adjusted to the strength of the animals, then at the end of the day it will be too heavy. It is possibly for this reason they have never found favour in the South of India where the Persian wheel is unknown and where the water level in the wells varies greatly.

The mechanical methods of lifting water may be conveniently regarded as consisting of a source of motive power and of a pump and that within certain obvious limits any source of motive power may be coupled to drive any type of pump. At Allahabad nearly every modern type of engine was at work in the exhibition and most of them connected up to pumps. It will be convenient to tabulate the exhibits in two columns.

Type of engine.	*Type of pump.*
Oil engines :	Centrifugal pumps :
1. Petrol.	1. Open impeller.
2. Kerosine oil.	2. Closed impellers.
3. Liquid fuel.	3. Self-regulating.
4. Diesel engines.	4. Multiple stage.
5. Semi-diesel.	Chain pumps.
Gas engines :	A[illegible]
Vertical.	Cornish pumps.
Horizontal.	Three-throw pumps.
Steam engines :—	
Portable.	
Semi-portable.	
Windmills.	

It is only in the Madras Presidency that mechanical methods of lift irrigation are at all largely used by the cultivators, and my remarks on the exhibits at Allahabad are necessarily based on the experience that has been gained in the Pumping Section of the late Department of Industries.

The steam engine may be dismissed with a very few words. Even where coal is very cheap it cannot be recommended as suitable for the ryots' work. By the use of superheaters the fuel consumption has been reduced to a very low figure, but the engine requires a skilled attendant who must satisfy the requirements of the local Boiler Acts. For very small powers it is hopelessly beaten by the internal combustion engine, but for larger powers where coal is cheap, as in parts of Bengal, it is still the best type of motor that can be employed.

For agricultural purposes the type of engine which should be recommended depends largely upon the relative cost of the different kinds of fuel which can be used in internal combustion engines. Over the whole of India the price of kerosine oil varies but slightly, whilst it is only in places that a cheap supply of liquid fuel can be obtained. In the Madras Presidency liquid fuel is about half the price of kerosine oil and the consumption per brake horse-power is by volume practically the same, so that, although liquid fuel is not so clean and nice to use as kerosine oil, the large saving in cost outweighs these disadvantages and renders it desirable to employ a type of engine in which it can be used without difficulty. At one time the Diesel and the Hornsby-Ackroyd engines were the only two which were quite satisfactory to use, but since the expiry of the Ackroyd patents there are a number of engines on the market by different makers all of which run well enough with liquid fuel. The Diesel engine is not suited for small powers and requires a skilled attendant to keep it in good running order. Its capital cost is also high, and for these reasons it may be considered out of the agricultural field. Within the last year or two English makers of oil engines have put on the market what may be termed a 'Semi-Diesel' engine, of which at least one example was to be seen at Allahabad. It was working very smoothly and the consumption of fuel, though higher than in the Diesel engine, was much below that usually obtained in ordinary oil engines working with liquid fuel. Where a portable oil engine is required, the work is not only intermittent but generally of a special

character that will bear the cost of a rather more expensive fuel, and there were exhibited several small vertical oil engines which would run on petrol or on kerosine oil if first started with petrol. Such engines invariably run at a very high speed and require to be of good design and the best possible workmanship. A cheap engine of this type is therefore not to be recommended, but if a sufficiently high price is paid, it is possible to get a really satisfactory motor. They are usually magneto fired and it is important that the magneto should be of an approved type. I have used one of these engines coupled direct to a 3-inch centrifugal pump during the last three years and found it admirably suited for testing water-supplies or any other work of a temporary character such as cleaning out temple tanks. I understand that the local conditions are such in the United Provinces that portable engines are likely to prove very useful, and I think that on the whole the light high speed type will be found better suited for this class of work than the ordinary type of oil engine mounted on a girder frame.

Where wood charcoal can be obtained at a cost not exceeding Rs. 20 per ton, gas engines and suction gas plants represent for anything over 10 h.p. the most convenient of type of motive power that can be employed. There are many designs of gas engine now on the market which work extremely well and with most gas producers charcoal can be used if adequate provision is made to remove the tar which invariably comes over. Suction gas engines are now made which will work with wood, paddy husks or straw, but they cannot well be employed for anything under 35 h.p. I have no extended experience of this class of fuel, but I am satisfied that they will do all that the makers claim for them, and I am now installing one to drive a 72 h.p. gas engine.

There were several windmills exhibited at Allahabad, but owing to the lightness of the winds during the exhibition it was impossible to get them to work against any load. Where fairly strong continuous winds can be relied upon, a windmill is a very suitable type of motor for well irrigation when the lift is not more

than twenty-five feet. On the West Coast of India and in the Deccan there is sufficient wind to make it worth while to put up these mills, but over the rest of India the air currents are usually too light and of too variable a character to obtain results commensurate with the capital outlay involved. It should be noted, however, that the wind velocities are usually the highest during the hot dry months of the year when water is most required.

Turning now to the various power-driven water-lifts attention may be drawn to the *norias* and chain-pumps. For small lifts, and not very large volumes of water, the chain-pump appears to have a possible future in front of it, but without prolonged experience as to the life of the chain and the general wear and tear and without accurate tests as to its efficiency I am not prepared to say that it is better than a centrifugal pump. Some well-designed *norias* driven by small engines were also exhibited, but I doubt if they can hold their own either in first cost, efficiency or durability with the best modern types of centrifugal pumps. For irrigation work it is hardly necessary to consider the various types of high pressure pump, either of the reciprocating type or the multiple stage centrifugal, as it will be a long time before agriculturists in India will be sufficiently advanced to venture to lift water from depths which will involve working against high pressures. It remains, therefore, only to consider the single stage centrifugal pumps, and of these practically every modern design was in evidence at the exhibition. It is quite beyond the range of these notes to enter into a discussion of the principles on which the various forms of this pump are designed. The efficiency of a centrifugal pump increases rapidly with increasing size, and pumps below 3" in diameter of suction pipe should ordinarily not be employed. The majority of 3" centrifugal pumps on the market have an efficiency ranging between 40 and 45 per cent., and the larger pumps will have an efficiency up to 55 per cent.; but during the last few years much attention has been paid to the design of centrifugal pumps, and 3" pumps can now be obtained with an efficiency of 70

per cent. and the larger sizes with an efficiency of nearly 80 per cent. These pumps are naturally more costly than the older types, but they require for equal quantities of water delivered a much smaller engine, and we find in Madras that it pays well to buy centrifugal pumps of the highest efficiency obtainable as the combined cost of the engine and pump is lower and the working expenses permanently less. Where the vertical lift on which the pump works varies considerably at different times of the year, or as often happens in wells during the course of the same day, there is a great advantage in using self-regulating pumps, and these can now be obtained which practically take the same amount of power over a very long range of lift. This is a very important matter when internal combustion engines are used, as such engines can only be efficiently worked near their maximum load and will not stand any over-load whatever. Till the self-regulating pumps came on the market we often fitted the ordinary type of centrifugal pumps with two fast pulleys of different diameters so that the speed of the pump could be roughly varied to suit marked changes in the height of the lift. Previous to the adoption of this practice the variations in the water-level rendered the working of centrifugal pumps extremely unsatisfactory, and in more than one instance I have known a rise in a river so increase the load thrown by the pump on to the engine as to pull it up. This may sound paradoxical, but it is well known to those who have much experience in the working of centrifugal pumps and the difficulty has been entirely eliminated since attention was first drawn to this point in one of our reports on Irrigation by Pumping.

The exhibition of water-lifts at Allahabad demonstrates conclusively that Mechanical Engineers both in England and India are becoming alive to the fact that a great market awaits them in connection with lift-irrigation in India, and we may confidently expect that competition for business will lead to a careful study of the problems and that great improvements will ultimately result. It is a matter for regret that the recently invented Humphrey Gas Pump did not arrive in time to be shown in

working order at the exhibition. It represents a revolution in our methods of generating power, but the exact range of its application can only be determined by practical experience. So far, the pumps constructed have been of a capacity much greater than will ordinarily be required in India, and it is certain that the details of the design will require to be greatly modified before it has any chance of proving a serious rival to the small pumping plants for which a very big field undoubtedly exists in India.

III. AGRICULTURAL PRODUCE.

By E. J. WOODHOUSE, B.A.,

Economic Botanist to the Government of Bengal

The exhibits in the agricultural and irrigation machinery section of this exhibition can probably be considered to hold forth good prospects of considerable improvement being effected at an early date in the methods of cultivation and irrigation used by the more enlightened Indian agriculturists. On the other hand, the exhibits in the Agricultural Produce section serve rather to show what an immense amount of work there is yet to be done on Indian crops, before they find their correct uses and attain their correct position in the markets of the world.

Before discussing the Produce section as a whole, it will be well to review briefly the exhibits shown in this section. The majority of the exhibits were housed in two buildings to the south of the Irrigation tank. These buildings were about 100 feet long and were conveniently arranged in the form of a cross with benches round the sides made up of two shelves, the upper one foot and the lower one foot six inches broad. Additional space was added by dividing up the longer sides into eight bays about 10 feet by 10 feet, in addition to the larger one in the centre of each side. Down the centre of the building were arranged stands for exhibits, models, and large show cases. The

eastern building was largely occupied by a large number of wheat samples, classified according to the system in Howard and Howard's "Wheat in India." Next to the wheat samples were set models of wheat elevators and flour mills. A part of one side of the building was occupied by diagrams and baskets of grain showing the results obtained by the use of different manures on wheat, maize, and potatoes, and the effect of sowing maize broadcast and in lines. In the west bay Messrs. B. C. Gupta, & Co., seed merchants of Sisauli, had a good exhibit of their seed grain. Some interesting exhibits, organised by the Registrar of Co-operative Credit Societies and the Muzaffarnagar Zemindari Association, were also shown in this building. A stand in the middle of the building was occupied by an exhibit from Pusa, demonstrating the value to the agriculturist of the commoner Indian birds. On the upper shelf of the stand were set up stuffed specimens of the commoner birds; and below them were arranged show cases containing the various insects constituting their food, divided up into classes according to the harm or good they do to the agriculturist. In addition to these there were a large collection of entomological show cases, and on the wall above them a number of plates of insect pests, arranged in frames according to the crop damaged. A good show case of scientific apparatus, together with specimens illustrating the life-history of insects and protective resemblance in insects, was exhibited by Messrs. Lawrence & Mayo in this section.

The second building was devoted largely to rices, oilseeds and fibres, in addition to which there was a collection of machinery exhibited by Messrs. Volkart Brothers, Karachi, and a model of the Skeen water-lift, recommended by the Bombay Department of Agriculture for utilizing the weight of one man and a bullock. Messrs. Thacker, Spink & Co. had a good assortment of agricultural literature, and the Peninsular Tobacco Company, Monghyr, had a large stand of tobacco exhibits. Down the centre of the north end of the building were arranged a series of exhibits of brushes, cotton seed oil, and sugar manufactures by Messrs. Begg, Sutherland & Co., and in the centre of

the building was placed an excellent ornamental stand of linseed oil exhibits, with working models, by the Gourepore Co., Calcutta. In this building there were also exhibits of sugar by the Cossipore Sugar works, and of tea by the Eagle Tea Co.

South of this building was the Pusa silk house containing a large number of useful machines, such as a loom, combined twisting and doubling machine, Pusa continuous spinning machine, and Coryton reversing machine, for *eri*, and the Bengal reeling machine for mulberry silk: the working of all of which was being demonstrated by trained coolies. In addition there were specimens of all the various kinds of cocoons and crosses made with them, and a large number of pieces of cloth made and dyed in Bihar. Some of the colours obtained were very pleasing and it is hoped that there will be a good demand for the silk ribbons and cloth for use as carriage rugs, purdahs and dress materials. Leaflets on the subject of *eri* and mulberry silk cultivation were also obtainable in this section.

One of the best exhibits in the agricultural section was the pot culture house devoted to cottons, which illustrated the work that has been done in the United Provinces in the improvement of the local cottons. The exhibit consisted of a central stand, on which were arranged photographs of the varieties on which work is being done, and drawings illustrating the behaviour of the characters of flower and leaf colour in crossing; from which it is possible to identify the accidental crosses which arise in cultivation. A series of cottons on ruled paper also showed the length of fibre attained by crossing the common short-stapled form with a longer stapled variety; in the first generation a regular intermediate form was obtained, and in the second generation the long and short-stapled forms were found to separate out. As a result of this work it is hoped that it will be possible to introduce a good, hardy, short season variety with lint of good length. Round the outside of the exhibit were growing specimens of the different varieties of cotton.

In the Fruit House there was a fruit bottling outfit and a good collection of bottled fruits from the Kumaon gardens

including cherries, apples, peaches, plums, apricots and various wild fruits. Among the fresh fruits were a number of dishes of apples, pears and walnuts from Almorah, some thin-skinned walnuts from Garhwal, a good collection of persimmons from Bhowli and a collection of citrus fruits from Kumaon. In the vegetable section there was an excellent collection of potatoes from Naini Tal, and an assortment of vegetables from the Kumaon gardens.

Of the various exhibits of agricultural produce, the rices were well represented and were made more easy to judge by the fact that samples of both rice and paddy had been requisitioned for exhibition, in addition to specimens of the ripe plant, which were mounted on frames, and considerably improved the appearance of the exhibits. Except in a few cases, the rice had been badly cleaned by the sun-drying process, and there were very few good samples of clean white unbroken rice. The best table rices exhibited were *Bansmati*, *Hansraj*, and *Ranjeraiy*, which latter variety appears to be the same as the *Dudkhani* variety of Bengal. It is said that there are only one or two fields in a few localities where *Bansmati* can be grown successfully, and in those localities the paddy is so sweetly scented that it can be recognised at a considerable distance, when ripe for harvest. The broadcast early rices were particularly badly cleaned, the most prominent being a red-grained variety, *Shati*, which appeared to be the same as that cultivated in Bengal. Of the wheats there were also a large number of samples of all the common types, but they did not appear to be so pure as the samples of rice exhibited. In the barley section there were a number of specimens of huskless barley, which looked well, but the variety is said not to yield so well as the ordinary. Of the oilseeds, there were a good number of specimens with good samples of oil attached to many of them. In the fibre section there were a number of excellent samples of jute, Manila hemp, Sannhemp, Urena, Sida, etc., sent by the Fibre Expert, Eastern Bengal and Assam, and some specimens of *Madar* (Calotropis) floss woven into cloth, exhibited by the

Agricultural Station, Aligarh. There were also a number of forest fibres exhibited by Dr. V. S. Joshi of Ratnagiri, Bombay. It is difficult to criticise the exhibits in the Fodder House, as most of them were pulses and cereals usually used as human food-stuffs. The difficulty of judging the exhibits was increased by the fact that a large proportion of the exhibitors had not complied with the requirements of the schedule. The arrangement of samples, which were not for competition, in the classes to be judged, also increased the difficulties of judging.

We may now leave the consideration of the individual exhibits to consider the Produce section as a whole. The statement in the official handbook that the general idea underlying this section had been "the intimate association of processes and products" shows that it was intended to function as a temporary Museum of Economic Products as well as an Agricultural Show with classes for competing entries. In order to understand how agricultural exhibitions have developed on these lines it is necessary to go back some years. It would appear that the exhibits at the early Indian Exhibitions consisted of samples brought together with the intention of submitting them eventually to European experts for report on their merits. At the Nagpur Exhibition of 1908 a small collection of the chief crops of the province with the recommendations of the local Department of Agriculture was staged separately from the section open to samples for competition. The chief object of the Lahore and Allahabad Exhibitions appears to have been the collection of as many samples of each crop as possible and their arrangement together, irrespective of their source, in order to make as imposing a display as possible. In other words, in these two exhibitions the functions of a museum and a competitive show were not differentiated.

A little consideration will show that these two objects are quite distinct. The use of an exhibition as a means of making an agricultural and industrial survey of a province for educational and museum purposes necessitates the collection of small samples of all the products found in the various tracts and the

preparation of models of the processes by which they are prepared for the market. With the present organisation throughout the Provinces of India such a survey, if necessary, can be made more efficiently in other ways. For an Agricultural Exhibition to perform the function of a Museum, only one sample of each product or process will be required and that must be the best of its kind. The exhibits should also be very carefully labelled, so that the public can see at once the advantages of each. On the other hand, in the case of a show proper there will be a class for each of the principal varieties of the crops and implements, etc., grown or useful in the locality; in each class many specimens of varying degrees of merit will be staged, and those considered by the judges as the best of each kind will be awarded prizes.

In order to show clearly what must happen if no distinction is made beween the exhibits shown for educational purposes and those shown for competition, it will be convenient to take a hypothetical case. At Allahabad there were a large number of samples of crops from various Associations and Government farms exhibited among the competitive entries, but not intended for competition. Now, supposing that a sample of the best of the improved wheats from a Government farm was exhibited in one of the wheat classes, where the rest of the entries were of poor quality; in judging the class it would be necessary to pass over the improved wheat, which was not for competition, and give the prize to a much inferior sample. The result would be that any member of the public who studied the exhibits in this class intelligently would at once infer that the improved wheat was really of inferior quality, and that wheats of the type of the winning sample were those which would be likely to fetch the highest prices. Cases exactly similar to this did actually occur at Allahabad. It is quite conceivable that this practice of combining an educational museum with a competitive show may give results the exact reverse of those desired.

An Agricultural Exhibition, to be successful, must therefore not be inspired by a mixture of ideas however good in themselves.

Both the demonstrations and competitions have as one object, the setting up of correct standards of excellence for the crops of the country, but, if it is desired to combine the two methods, this should be done by including in a separate museum exhibit samples, approximating as closely as possible to the ideal, of types of all the principal crops grown in the country, with labels giving the current valuation and other remarks on the advantages and disadvantages of the crop. The competing exhibits would then be classified according to each of these types, and the prizes awarded according to the approximation of the exhibits to the standard set in the Museum. Implements, models, etc., could be treated on a similar system.

It may be asked whether it is possible to lay down definite standards of excellence for the majority of Indian crops: and to anyone who has been faced with the problem of judging a long line of samples of *Cheena* (Panicum miliaceum), this question will seem a very pertinent one. Undoubtedly there are a large number of crops, concerning which very little is at present known, but it will be found that in the case of many of these crops, such as paddy, *rahar*, *mung*, there are definite local standards of excellence.* In the case of such crops it is only possible to award prizes according to the requirements of the local bazars, at the same time taking into account the purity, cleanliness, and thriftiness of the sample. On the other hand, the staples of European consumption, among which may be included wheat, cotton and other fibre crops, have very definite standards; and it is by instituting classes for these crops in particular that agricultural shows can disseminate a knowledge of the factors which go to make up the value of a sample. To be effective, this work must be begun by means of small shows held in the heart of the various agricultural tracts.

* Some information on this head has been collected in the Bengal Department of Agriculture's Record 1 of 1910, *Suggestions as to the organisation of agricultural exhibitions.* There is an immense amount of work yet to be done in isolating the "Varieties" (unit species) of the minor crops, finding out the reasons for the local preferences, and inquiring into the possibilities of an export trade in them.

The future development of agricultural shows will probably lie in the improvement of the classes for competition. A reduction in the number of the produce classes can be made by eliminating classes for minor crops, which have probably only been retained on the schedules of exhibitions on account of the small amount of information that exists concerning them. Such a reduction in the number of classes will enable the prize money to be increased in the important classes. At the same time the size of the samples can probably be increased until they may eventually reach a maund, which will enable judgments to be given on a more commercial scale. The development of the competitive side of an exhibition on these lines will make the present scheme of arrangements and decorations more or less impossible, except round the stands where the selected exhibits for demonstration purposes are separately staged. The efficiency of the demonstration section will be increased by its isolation from the competing exhibits and by the improvement of the methods of staging and labelling.*

The moral of the Allahabad Exhibition seems to be that an exhibition of mechanical appliances for agriculture tends to attract the attention of innumerable commercial establishments fully alive to the advantages which may accrue to themselves from the application of the mechanical ingenuity at their command to the problems of Indian Agriculture, and may therefore be of the utmost utility, but that no real development of exhibitions of agricultural produce on the scale of the Allahabad Exhibition can take place until very much more is known of the economic possibilities of Indian crops and the characters of their constituent varieties. In the meantime small shows, held in the

* In Bengal the larger Department [illegible] is arranged in a separate tent, and the [illegible] exhibits are divided into two sections, [illegible] crops recommended by the Department for general cultivation and [illegible] section containing samples of the [illegible] varieties usually grown in the Province [illegible] to show the public the crops which [illegible] be grown in the Province. It was as a result of the interest taken in a flood-resisting paddy exhibited in this section, by [illegible] cultivators at [illegible] that a deep water paddy is [illegible] successfully introduced into North B[illegible]. Further information regarding the setting up of these exhibits can be obtained [illegible]

heart of agricultural tracts, can be effectively utilized to advertise the recommendations of the Agricultural Department, to set up correct standards for the important staples, to show the value of good clean samples of other produce, and to encourage the spirit of competition. Incidentally they will also be found to provide material for the Department's survey work at a minimum of expense.

SUGAR-CANE IN INDIA.

By J. WALTER LEATHER, Ph.D., F.I.C.,

Imperial Agricultural Chemist.

India is importing more than half a million tons of sugar annually.

This statement will sufficiently indicate the object of the present article. It is not merely that the above indicated quantity is large, but it is also one that is constantly increasing. Twenty years ago India purchased 100,000 tons of sugar: ten years ago the import had risen to 300,000 tons: now it is in excess of 600,000 tons. The fact is all the more striking when it is recollected that India produces more sugar than any other country, the estimated production being about three million tons. Two questions at once occur to the mind, which are :—

(*i*) is the transaction a sound one? and

(*ii*) can it be avoided?

The reply to the first of these is, I think, both simple and definite. During the last twenty years the cultivated area has increased by about 21 million acres, which area has been utilised for the expansion of the wheat, cotton, oil seeds and food-grain crops: at the same time there has been no corresponding increase in the sugar-cane area, which has in fact suffered some slight decline. These facts are demonstrated by the following statement :—*

Statement of areas in British India (Millions of Acres).

	Total Cultivated area.	Wheat.	Cotton.	Oil seeds.	Sugar-cane.
Average of 5 years 1894-95 to 1898-99.	191	19·6	9·4	12·6	2·8
Average of 5 years 1899-1900 to 1903-04.	198	19·8	10·2	12·6	2·5
Average of 5 years 1904-05 to 1908-09.	212	22·6	13·4	13·4	2·4

* Agricultural Statistics of British India.

As a business transaction, the position is perfectly sound: for it is clear that under present conditions it pays the Indian cultivator better to grow other things than sugar and to purchase the latter. It is an example on a very large scale of what happens in the case of many districts on a much smaller one, some of which never grow any sugar at all, but always purchase what they require.

But when we turn to the second question and consider whether India can avoid purchasing these large quantities of sugar, the answer is by no means simple. In one sense the position can be defined, for it is evident that it will only pay the cultivator to grow more sugar if (i) its price rises, or (ii) the crop can be raised more cheaply, or (iii) more sugar can be produced per acre, or naturally if a combination of these conditions can be realised. Regarding (i) it is highly improbable that any rise in price will occur. It is true that the world's demand for sugar constantly increases, but the future of sugar may be expected to be similar to its past, and it will be produced more and more cheaply. There is, however, one important point which deserves mention here. Whilst it may be expected that sugar will become cheaper, there will be a limit to such fall in price, because there is no probability that all the other sugar producing countries could together supply India's whole demand. The latter is about 3·5 million tons. At the same time, even supposing one million tons were imported, this would be no reason for assuming a rise in the price. Also in respect of condition (ii) which implies cheaper labour, there is no probability of this being realised: wages will rise and agricultural machinery has not so far helped to decrease the labour bill for cultivating or harvesting the sugarcane crop. At the same time there is some evidence that the cost of cultivating an acre of cane in India is high. Hadi estimates* this at about Rs. 65—80 per acre. It is not easy to compare accurately the cost of cultivation in other countries, but so far as I am able to do so, the following may be given. Cuba, Rs. 100

* Sugar-cane Industry of United Provinces, p. 42.

Louisiana, Rs. 26 : Java, Rs. 30.* The Cuba estimate is based on a production of about 30 tons cane per acre. But if the cost in India is really greater than in Java, it is difficult to see how it can be reduced. The solution of the difficulty clearly depends on condition (iii), and if India is to avoid her current very large sugar bill, she must increase the outturn per acre and extract a larger proportion of the sugar which is in the cane.

It will probably be best to consider first the question of extracting a larger proportion of the sugar from the cane. It is well known that the amount of juice expressed from cane depends on the efficiency of the mill. We are not considering here whether one sort of cane will yield more juice than another, but purely the outturn of juice from any cane when crushed by good and bad mills respectively. The best mills are no doubt those which are working in the large factories. Here the presence of the engineer secures that the mills are kept in good repair, and over and above this, the cane passes from the first mill along a "feeder" to a second mill and is on the way wetted with water, so that a further quantity of juice is obtained, albeit much diluted ; and this process is repeated a third time in the most modern factories. Passing from this in the downward scale, we have power driven mills badly cared for, the small iron bullock-driven mills so largely used by the cultivator, and finally the old wooden mills of various patterns which have practically disappeared in India. Comparing the small bullock power iron mill which has come into such general use in India during the last twenty years, with the best steam-driven mills, it is quite easy to argue that the latter will extract much more sugar from cane than the former. If both are in good repair, it is probable that the steam-driven mill will extract from one-eighth to one-fifth more. With the aid of the *best* mills, with double and treble crushing 90 to 94 per cent. of the juice is obtained,† from which we may deduce the following. It is usual to obtain from the thick varieties of

* Das Zuckerrohr und seine Kultur, by W. Kr[illegible] 189[illegible].
† On cane-sugar and the process of its manufacture in Java, by H. C. Prinsen Geerligs.

cane grown in Southern India 70 per cent. juice, the total being about 90 per cent. in the cane. A steam-driven mill of *good* type with double or treble crushing will not extract more than about 80 per cent. From the thin canes containing about 85 per cent. juice, a good pattern bullock-power mill will extract 60 per cent., whilst a steam-power mill would extract about 76 per cent. Unfortunately the small bullock-driven mill is often at a disadvantage for want of being kept in good order. For example, in a test made by Mr. Mollison some years ago at Dharwar* one iron mill expressed one-sixteenth more juice than another pattern, and Khan Bahadur Md. Hadi quotes† cases in which a well-made mill extracted from one-tenth up to one-fifth more juice than mills found in villages. Again, Mr. Moreland has stated‡ that the examination of the stock of mills in one sugar centre revealed the fact that not one was fit for use, and the same was found in another large tract of country, and he adds "at a very low estimate I believe that the effective yield of juice per acre could be increased by 10 to 15 per cent. if efficient mills were procurable." In fact, one of the chief defects of the small mill is the difficulty of maintaining such a very large number in good working order.

Adding to defective working the fact that the best of these small iron mills could not compete with the best power mills in which the cane is "double" crushed, one is apt to assume that, were all India's cane crushed by the latter, an increased yield of something like one-fifth more sugar would result. And one-fifth more sugar is equivalent to India's imports! But such an estimate overlooks one or two features which considerably modify it. In the first place, all the cane of India will not, in our time, be crushed by the best power mills. Circumstances are generally opposed to such a huge change. Then, secondly, power mills are not necessarily better than the small iron mill. For instance, at the recent

* Agricultural Ledger, 1898, No. 8, p. 21.

† Sugar-cane Industry of United Provinces, by S. M. Hadi, p. 61.

‡ Agricultural Journal of India, II, p. 16.

Exhibition at Allahabad one of the latter type beat several power mills in open competition, though it must be here noted that the latter were only "single" crushers; that is, the begass was not treated with water and then again crushed, as in the more perfect types. Thirdly, very large quantities of cane are required to feed a good steam-driven mill, and this means almost necessarily a serious delay after cutting the cane before it is crushed. For instance, cane has to be brought some 40 or 50 miles by rail at the present time to some of the mills in India and is certainly not crushed before the second or third day after being cut in the field. Mr. Noel-Paton in his valuable paper "Notes on Sugar in India" places great weight on the importance of this factor. Cut cane suffers depreciation if not crushed within 24 hours. But he errs when he attributes (p. 38) to the general Indian practice, loss from this cause. One of the great advantages of the present system in India is that the cane is cut only as it is required, and hence does *not* suffer from this source of depreciation. Indeed loss of sugar from this cause would have to be set against the various advantages which the steam driven factory offers. In any case, whatever extension of steam power crushing there may be in the near future, it is certain that this will not make any *large* difference in the amount of sugar which is obtained from the cane grown.

So long as the greater part of the people of India are satisfied with *gur*, its production is neither a loss nor a disadvantage, but rather the reverse, because both in the sense of a sweetmeat as also in that of a food-stuff the molasses included in the *gur* is just as valuable as the cane sugar. An increase in the number of factories in India is no doubt desirable in order to supply a part at least of the demand for white sugar, but they will not be a means of increasing the sugar *production* in any marked degree. If the *production* is to increase, it must be by means of (*i*) a larger outturn of cane per acre, (*ii*) the cultivation of cane yielding more sugar at the mill, and (*iii*) an extension of the area under cane, and the problem is largely independent of whether the cane is crushed by the cultivator or goes to a factory. In

approaching this subject it is well to compare the outturn of sugar per acre which is realised in different countries; Java seems to head the list with an average of 3 to 4 tons per acre; Demerara, Mauritius and Queensland produce rather under 2 tons. Coming to India we have:—

Bombay* ...	...	2·5 tons per acre.	
Madras ...	...	1·9 ,,	,,
Eastern Bengal & Assam	...	1·05 ,,	,,
Bengal ...	...	·9 ,,	,,
United Provinces ...	...	·8 ,,	,,
Punjab ...	...	·6 ,,	,,

Although these figures for the several countries are not strictly comparable, because "sugar" in countries outside India means more or less refined sugar, whilst in India it means *gur*, they are nevertheless useful for our purpose.

Firstly, they show how much more is obtained per acre in most countries than in India. It seems certain that, so long as the disparity is so great as it is, so long will these other countries be able to produce sugar cheaper than India can. That this is not principally due to the central factory system is certain. The figures represent principally differences *in the field*.

Then, secondly, considering the Indian outturns, it is evident that the tropical parts of India produce considerably more sugar than the United Provinces and the Punjab. And in this lies probably one of the "keys" of the situation. It so happens that by far the greater part of India's sugar-cane area lies outside the tropics, and concurrently a considerably lower yield per acre is realised. The question then arises, is it reasonable to expect that these sub-tropical countries can ever produce such yields as the tropical countries do? And here let it be noted that India's cane is not of low quality in so far as proportion of sugar in the juice is concerned. Average cane-juice in Java contains from

* Last five years average from "Final Government Memorandum on the sugar-crop of the season 1910-11" issued by the Commercial Intelligence Department.

15 to 17* per cent. of sugar, which is certainly not higher than that of Indian cane. These figures will appear low to some readers. It is quite true that *some* cane grown in Java is richer than this and runs up to as much as 20 per cent.: but this is likewise the case in India. The defects of the Indian crop are (*i*) small weight of cane per acre, and (*ii*) a high proportion of fibre in the cane, which causes, especially in single crushing, a low yield of juice.

The production of more cane per acre and of cane yielding high proportions of juice, containing high proportions of sugar, are subjects well understood, but the solution of the problem in India is not by any means a simple one. The United Provinces include more than half the sugar-cane area, and the visitor from other cane-growing countries is at once struck by the small thin canes which are nearly universally grown. Why grow such cane, a cane indeed which contains a high proportion of fibre and consequently yields less juice to the mill? As a matter of fact, the general growth of these thin canes is not due to mere ignorance on the part of the cultivators. Thick canes of better quality are grown in small quantity very widely throughout the Province and are called *Poundas*, which are, however, generally sold for chewing, and only in the Meerut Division is a moderately thick cane crushed for sugar manufacture. Why is this the practice? One reason given is that the *Poundas* are not "sweet," that is, the juice is said to contain a low proportion of cane sugar. Such evidence as we have does not support this argument. Even if the *Ukhs* are somewhat sweeter, they contain less juice. Assuming for example that the juice of the *Ukhs* contains on the whole 17 per cent. sugar whilst *Poundas* contain 15 per cent., then since the *Ukhs* yield about 55 per cent. juice, and the *Poundas* 70 per cent. juice at the mill, 100 pounds of *Ukh* cane will yield $17 \times \cdot 55 = 9{\cdot}35$ pounds of sugar at the mill, whilst 100 pounds of *Pounda* will yield $15 \times \cdot 7 = 10{\cdot}5$ pounds of sugar. Other reasons are that the *Poundas* are more liable to disease

* Das Zuckerrohr und seine Kultur, by W. Krüger, p. 156.

and are more freely attacked by jackal and pig. Also they have not generally tillered so well in Behar as they do in Southern India.

A first consideration towards the improvement of cane as a sugar producer is the cultivation of a cane which will grow well in the particular locality. Nothing has been more striking when attempting to improve the yield of cane than the sensitiveness of newly introduced canes to novel environment. This is of course well known, but perhaps not generally realised. For example, two varieties of cane were obtained from Mauritius in 1894 for growth at Poona.* In respect of weight of cane they did well, but instead of yielding juice containing 18 per cent. sugar as had been expected, they only contained some 10 to 12 per cent. They only slowly improved. Similarly canes brought from Poona, from Burdwan and from Saharanpur to Cawnpore in 1897 grew very defectively. At Pusa, too, many of the varieties which have been obtained from other parts of India have failed to do well. At the same time, and conversely, some have done well, and have yielded good crops of sound and rich cane, though subject to disease in certain years. Curiously, too, among those that grew well at Pusa were the two Mauritius canes from Poona which did so badly there at first. These yielded juice containing 18 to 20 per cent. of sugar.

Thus it follows that when attempting to improve the cane of a district, a most laborious piece of work is involved, extending as it must do over a number of years, in order to ascertain what varieties from other parts may do better than the local one. Again, what is ascertained to be the best cane at one Experiment Station is not necessarily applicable to a whole Province. Owing to differences of soil and climate each sugar-growing Province in India would require several sugar-cane stations in order to make the work at all complete. And the work cannot be much abbreviated, excepting that in some parts, more particularly the tropical parts of India, the varieties already grown are of a high quality.

* See this Journal, Vol. I., p. 413.

This is the line of investigation adopted by Mr. Clarke, Agricultural Chemist, United Provinces, and is one of the most important that can be followed.

Another means of increasing the outturn of sugar per acre is by liberal manuring. It is unnecessary to say that the crop responds to liberal manuring. It is not, however, the case that the cane land is not manured in India. Probably no crop is treated more liberally than is the sugar-cane crop in respect of good cultivation and manure. In some parts, notably the Deccan Districts, very liberal quantities of manure are used, and it is here that the outturn is very high. In most parts, especially the United Provinces and the Punjab, the quantity of manure employed is certainly small. In fact, in this respect the crop suffers like all others in India. At the same time it would be a mistake to suppose that by liberal manuring the outturn can be increased one hundred per cent. Some experiments were made at the Cawnpore farm between the years 1897 and 1903 with the object of trying to obtain there as large outturns as are commonly obtained in the Deccan. These showed that the heaviest crops raised were not one-half as large as those obtained in the Deccan, and moreover some of the cane, more especially the thin "*Ukhs*," suffered depreciation in quality. Moderate allowances of manure would no doubt be of advantage, but to employ the large quantities which are used in Southern India would probably do harm.

Passing from these considerations regarding the increased yield of cane in areas already under the crop, to the question of a possible extension of area, we meet with two facts. The one is that, despite the constant increase of total cultivated area, large increase of imports, and increased price of *gur*, there has been a contraction of area under sugar-cane. The three five-year averages which I have quoted indicate a contraction of some 400,000 acres in 15 years. Statistics are perhaps not altogether reliable in such cases. For instance, the contraction in the United Provinces in 1910-11 in comparison with the previous five years is some 200,000 acres, but so recently as

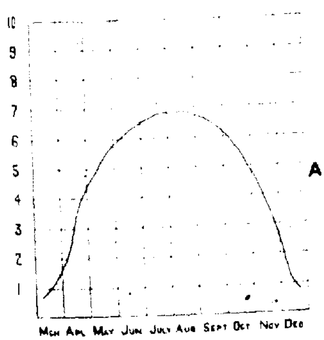
1907-08 this Province grew the largest area of the last 20 years. On the other hand, the Punjab crop of 1910-11 was one-third greater (more than 100,000 acres) than the last 5 years' average, but the latter included two crops very much below the average. At the same time there is, I know, a general feeling of anxiety in regard to the United Provinces crop, for if it is not contracting, it is certainly not expanding. In Bengal, too, which includes the second largest area, the answer is even more definite. It seems then unreasonable to hope for any large expansion in this part of India. Other crops pay the cultivator better.

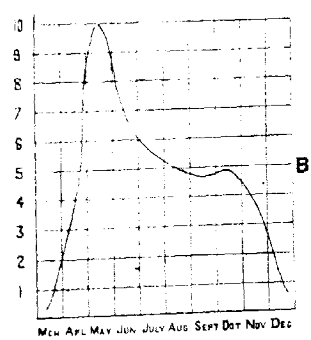
One of the most curious facts in relation to India's sugar-cane area is that it is nearly entirely situated outside the tropics. How comes it that the country which produces more sugar than any other should grow the crop in the more temperate parts, whilst nearly all the rest of the world's cane is grown in the tropics? It is certainly not because the outturn is large. As already demonstrated, this is far below the tropical average. The explanation is probably two-fold. Firstly, the Indo-Gangetic alluvium is a soil which possesses an unusual fertility: a fertility probably largely due to its water-holding capacity. A crop can exist in it through the hot weather when it would fail in most soils. Secondly, and probably principally, the facilities for cheap irrigation have been greater in the United Provinces than in other parts. The canal-irrigated area has always been large and where dependence has been on wells, the sub-soil water is near the surface. There is also some support to this explanation in the fact that the Punjab is the only province in which a distinct increase of area under cane has occurred in recent times, and this is the province which has had a large increase of canal irrigation. But is it not a fundamental mistake for India to grow most of her cane in those parts where the outturn per acre is necessarily so much below that of competing countries? The fact of it being so at present is not a complete answer. One might have hoped that with the increased irrigated area in Madras, some sign of an increased area under cane would

become evident, but apparently her people find it pays better to grow *cholum* (Andropogon sorghum). Eastern Bengal is again another Province possessed of a climate more in accordance with the requirements of the cane crop, but here jute holds the "field."*

But if, for one reason or another, it pays the Indian cultivator better to grow other crops than cane, why should not Burma make an attempt to compete with Java and Mauritius? The climatic conditions are there more nearly akin to what is required. The dry "hot-weather" as it is understood in the Gangetic Valley is absent. In its place is a heavy rainfall distributed throughout the months of April to November: the temperature is considerably more uniform and does not reach the high figures so common to the United Provinces: at the same time the humidity is considerably higher.

These climatological features are much more in accord with the requirements of the sugar-cane. The hot weather of the United Provinces occasions an excessive transpiration of water. In some recent work on this subject at Pusa, we found that the curve representing the water requirement of sugar-cane was as illustrated in the chart B, whereas in a humid climate it would





* Since writing this article I hear from Mr. Meggitt, Agricultural Chemist, Eastern Bengal and Assam, that he can grow very heavy crops of cane at Jorhat, and that there are large areas in Assam which are available and suitable, both as regards soil and climate, for the crop.—J. W. L.

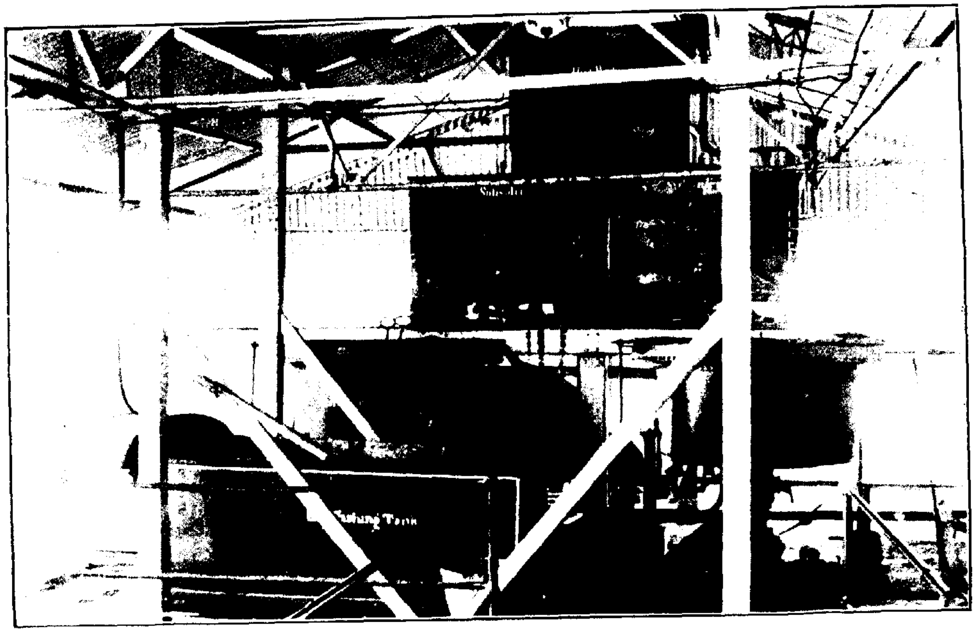
have been more like that in chart A. We may put the matter in figures thus :—

	March (2nd half).	April.	May.	June.	July.	August.	September.	October.	November.	December.
Temperature 8 A.M. ° F.	76	79	84	85	82	83	83	77	66	56
Relative Humidity 8 A.M.	47	50	64	79	87	86	89	83	84	[illegible]
Calculated water transpired by crop of 20 tons cane per acre ...	3″	4·0″	10·0	6·7″	5·7″	5·0″	4·6″	4·9″	3·5″	[illegible]
TOTAL ...	...	...							...	[illegible]

Thus, owing largely to the low humidity and high temperature during April, May and June, especially in May, the water requirement was considerably greater than would have been the case under more moderate conditions. The water indicated in the statement is that actually transpired by the plant, in addition to which there will be a further considerable quantity which is simply evaporated from the soil.

But in any case it must, I think, be accepted that so long as India's principal sugar-cane area lies outside the tropics, so long will the yield per acre remain far below that of the other principal producing countries.

PLATE XXXIII



A. J. J.

THE SUBSIDERS AND ELIMINATORS.

The bag filter (open for cleaning) is seen in the right-hand corner of the foreground.

THE SUGAR FACTORY EXHIBITED IN THE AGRICULTURAL COURT, ALLAHABAD EXHIBITION, BY MESSRS. BLAIR, CAMPBELL & McLEAN.

BY B. C. BURT, B.Sc.,

Deputy Director of Agriculture, United Provinces.

As this factory formed one of the most popular exhibits in the Agricultural Court, a few notes describing the result of the season's working will probably be of interest to readers of the *Agricultural Journal.* The inefficiency of the ordinary native method of preparing sugar, even when carried out by skilled sugar-boilers, as is the case in the Rohilkhand division of the United Provinces, is well recognised. The difficulties attending the introduction of large central factories are also equally obvious. The present plant, although by no means the first modern sugar-making plant erected in these provinces, represents the most recent and probably the most successful attempt to combine the efficiency of modern sugar-making machinery with a capacity suited to the conditions under which cane is commonly grown in the U. P.

This factory is designed to turn out $1\frac{1}{2}$ tons of white sugar per 24 hours working with average good cane. In design it differs little from larger factories except in the omission of an intermediate vacuum evaporator. The cane was crushed in a 5 roller mill fitted with a pair of splitting rollers and with three crushing rollers. With ordinary good thin cane of the type known as *Ukh* in Northern India this mill was capable of dealing with about 30 tons of cane per day, and gave an extraction of 66 per cent. The juice passing from the mill, after careful straining, was limed just short of neutrality. It was then passed through a juice heater, where the temperature was raised rapidly to 180°F. and then passed into the subsiding tanks. From the subsiders the juice was drawn into the eliminators where it was again rapidly heated by exhaust steam until albuminoid matter was coagulated. The juice from the eliminators passed through a bag filter and the

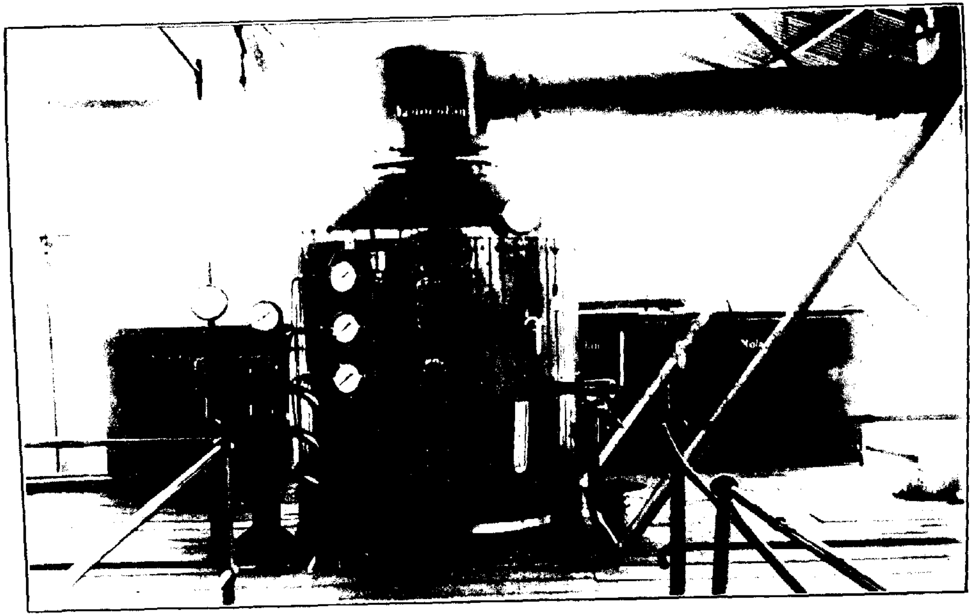
clear juice so obtained passed direct to the vacuum-pan supply tank. In the vacuum-pan the juice was evaporated, using a Torricellian vacuum, to crystallization point and the "grain" built up in the usual way. The "massecuites" obtained was dropped from the vacuum-pan into a rotary crystalliser from whence it passed to the pug-mill and centrifugal. In order to produce finely ground and dry sugar, the factory was also provided with a sugar-dryer, grinder and sifter. Plates XXXV, XXXVI and XXXVII.

It will be seen from the above description that the factory differs from an ordinary central factory only in size and in the omission of the usual "triple effect" intermediate evaporator. It was demonstrated throughout the exhibition that a small factory of this description could work efficiently and regularly without any intermediate evaporator. As, however, dilute juices were taken direct into the vacuum-pan, considerably more care than usual was necessary in boiling, and the time occupied in preparing a panful of massecuites was necessarily comparatively longer. Whilst fully recognising the increased heat economy obtained by the use of *triple effect*, the makers of the plant decided to omit this as they did not consider that a commercially efficient evaporator of this type could be fitted to a factory dealing with less than 4 tons of sugar per 24 hours.

The factory now described was considered to be the smallest possible, and this particular size was chosen because it will deal with an area—say $1\frac{1}{2}$ acres per 24 hours—which can easily be obtained within a reasonable radius in any good cane-growing district.

It was found that a sugar suitable for direct consumption could be produced at a single operation without using any other clarifying agent than lime. By careful boiling a fine crystalline sugar, corresponding very nearly with Bareilly *khand*, was obtained, which commanded a ready sale. By drying and crushing, a fine granulated sugar, corresponding very nearly in appearance with native *bhura*, was obtained. No difficulty was experienced in regard to colour. It is, of course, universally recognised that the separation of large crystals from massecuites is more efficient

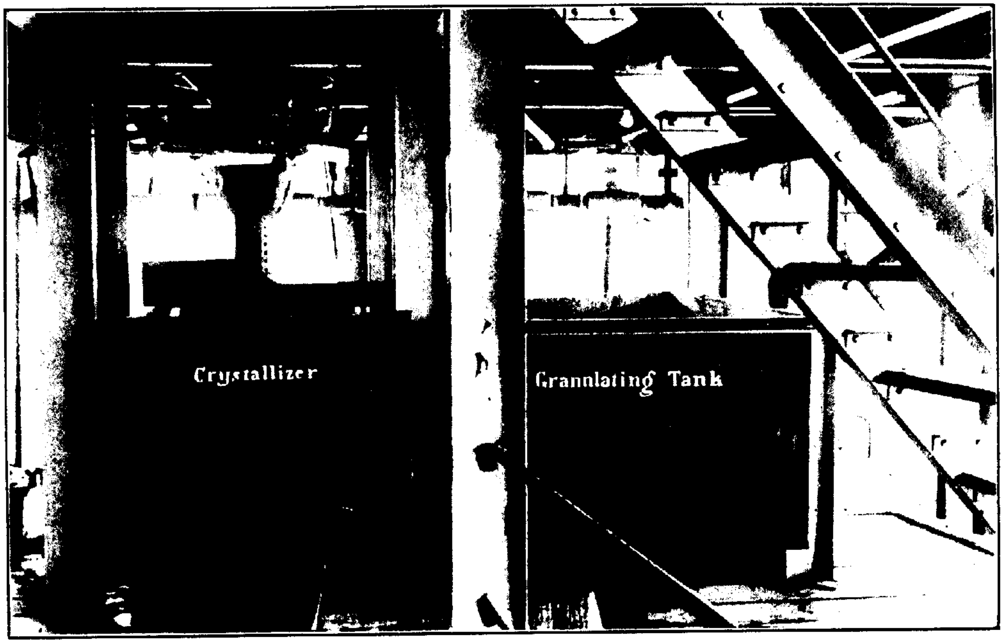
PLATE XXXIV



A. J. I.

VACUUM PAN.

PLATE XXXV.



A. J. L.

CRYSTALLISER AND GRANULATING TANK.

than the separation of smaller crystals, and in commercial practice each factory owner would have to decide for himself whether to sacrifice quantity to quality, or, in other words, whether to boil a large or a small grain. In boiling a small grain much more sugar passes through into the molasses; this can be recovered in the second or molasses sugar, and it was found that by careful boiling a molasses sugar of good quality and colour could be obtained. The whole of the steam for the factory was obtained from a single boiler fitted with a special grate for burning megass. Under favourable circumstances no other fuel was required.

II.—Efficiency of the Sugar Recovery.

The only possible way of judging the efficiency of a sugar factory is by determining what percentage of the sucrose entering in the factory in the form of cane or juice is recovered as marketable sugar. A short test of this description covering two full days working from cane and the subsequent boiling of a second sugar from the molasses was carried out after the close of the exhibition. Owing to the short time at our disposal it was decided to determine the percentage of sugar recovered from the juice. No chemical examination was made of the efficiency of the cane crushing mill. On the first day 2,313 galls. of juice containing the 4,096·3lbs. of sugar were supplied to the factory from which 1,938¼lbs. of first sugar was recovered equal to 47·3 per cent. On the second day 2,163 galls. of juice containing 3,400·2lbs. of sugar were supplied from which was obtained 1,897·5lbs. of first sugar equal to 55·8 per cent. From the mixed molasses aggregating approximately 415 galls. and containing 2,512lbs. of sugar 979lbs. of second sugar were obtained equal to 13·06 per cent. of the total sugar entering the factory as juice.

The total recovery of marketable sugar is 64·23 per cent. of the sugar in the juice, or since the 1st and 2nd sugars polarised 98·4 and 98·0 respectively, sucrose recovered as—

1st sugar	1st day	47·3 ×	·984	was equal to	46·5 %	of sucrose present in the juice.
1st ,,	2nd day	55·8 ×	·984	,,	54·9 %	,, ,, ,, ,,
2nd ,,	(total)	13·06 ×	·98	,,	12·80	,, ,, ,, ,,
1st ,,	average	51·17 ×	·984	,,	50·35	,, ,, ,, ,,
Total recovery		50·35 +	12·8	,,	63·15 %	= efficiency factor.

SUGAR LEFT IN MOLASSES.

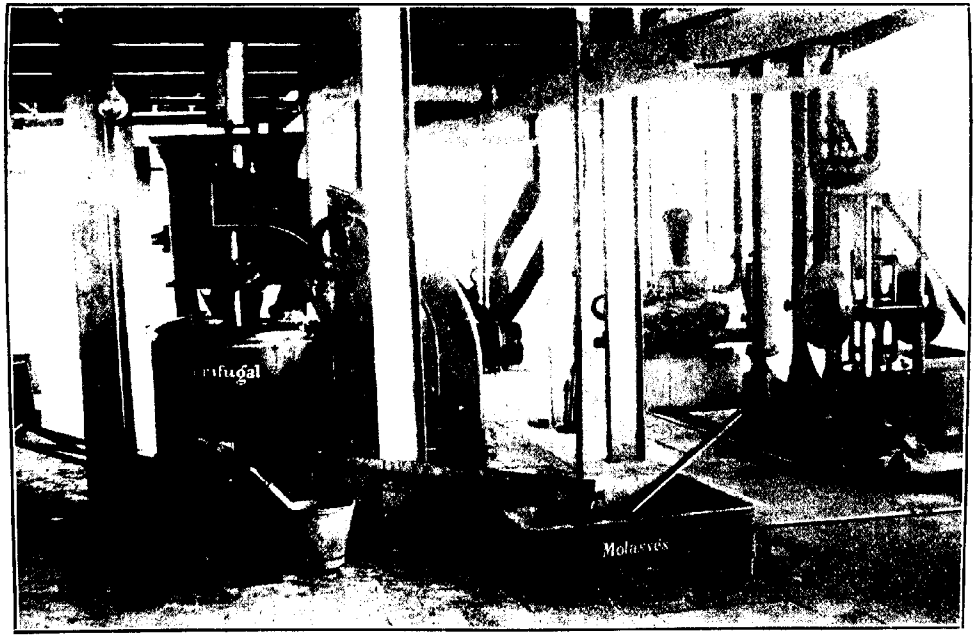
On the first day 234 gallons of molasses containing 1,547·6 lbs of sucrose were produced, corresponding to 37·8 per cent. of the sucrose entering the factory, leaving 100 – 37·8 – 46·5 equal to 15·7 per cent. manufacturing losses.

On the second day 181 galls. of molasses containing 965·3 lbs. of sucrose were produced equal to 28·4 per cent. Loss in manufacture, 100 – 54·9 – 28·4 equal to 16·7 per cent.

On the average of two days of 7,496·5 lbs. of sucrose supplied as juice, 2,512·9 lbs. or 33·5 per cent. was left in the first molasses, of which 12·8 per cent. was subsequently recovered, leaving 20 per cent. in the *exhausted* molasses.

There is a marked difference in the recovery of first sugar on the first and second day, and it will be noted that this is entirely in the recovery of sugar from massecuites. This is due to different systems of boilings adopted on the two days. During the first day's trial the factory manager asked permission to work by the process known as "seeding" in which a small (weighed) quantity of crystals is introduced into the vacuum-pan in order to promote crystallisation; this is a method in common use when sugars for direct consumption are made. It did not, however, in the present instance give such good results as the ordinary method of 'graining' in the pan. As two days' work barely gave enough molasses for the preparation of a second sugar, it was not possible to work up the two lots of molasses separately, and consequently it is not possible to state what the efficiency of the factory would have been, had the second day's efficiency in production of first sugar been maintained for both days. If we assume that the efficiency of the second sugar recovery remains unaltered, we obtain 54·9 plus 12·8 equal to 67·7 per cent. instead of 63·15 per cent. This assumption, however, is hardly justified since with a poorer molasses, the percentage of second sugar recovered would fall and the truth probably lies between the two. Probably we are not far wrong in taking the figure 66 per cent. as the efficiency factor of the factory, 16 per cent. as loss in manufacture and 18 per cent. of

PLATE XXXVI



A. J. I. To the left is seen the Centrifugal; to the right the Vacuum Pump and the Injector Pump; in the background the Main Engine.

sugar left in the exhausted molasses. For the analyses on which these figures are based, I am indebted to the Agricultural Chemist to Government, U. P., who kindly placed an assistant at my disposal for the purpose and checked the final analytical figures. The analyses themselves are given in Appendix A.

In a recent article* Clarke and Banerji have compared the results obtained with the Hadi process with those obtained in central factories in different parts of the world. For convenience these results together with those obtained above are tabulated below.

Table A.

Comparison of the efficiencies of different processes of boiling and clarification.

Sucrose recovered per 100 sucrose in Juice in—	Hadi process open pan boiling (Allahabad.)	West Indian Muscovado process open pans.	Hawaiian factory triple effect vacuum evaporation & carbonation.	West Indian central factory evaporation in vacuo.	Results of 95 factories in Java 1907.	Blair, Campbell and McLeod's factory, 1911.
First Sugar	39·9	67·75 (first and second sugar)	89·91 (first and second sugar)	72·4	89·91 (first and second sugar)	54·9
Second Sugar	15·5			9·9		11·1
Molasses ...	19·6	17·75	5·36	11·9	9·25	18
Inverted and destroyed in manufacture ...	19·2	14·50 (inverted and scum)	3·55	4·6	0·84 (inverted and scum)	16 (inverted and scum)
Scum and waste	5·8		1·18	1·2		
	100·0	100·0	100·0	100·0	100·0	100·0
Efficiency factor (per cent. total sucrose recovered)	55·4	67·75	89·91	82·3	89·91	66
First sugar recovered per cent. cane.	4·10 (Pol. 95·1)	7·15 (Pol. 90·0)	10·40 (Pol. 96·5)	8·60 (Pol. 93·5)	10·09 (Pol. 97·8)	5·76 (Pol. 98·4)
Second sugar recovered per cent. cane ...	1·76 (Pol. 86·9)		3·19 (Pol. 90)	1·26 (Pol. 90)	....	1·21 (Pol. 98)
Total sugar	5·86	7·15	13·59	9·86	10·09	6·97

From the above table it will be seen that, as compared with the Hadi process (the only Indian process for which figures have been published) 15 per cent. more sucrose is recovered as first sugar

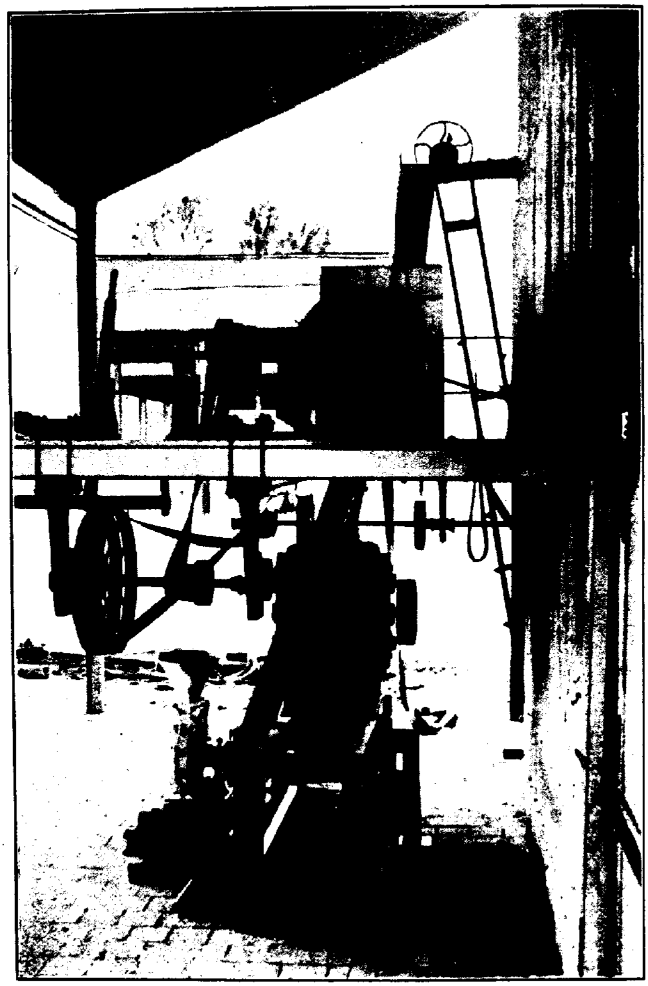
* Clarke and Banerji. The efficiency of the Hadi process of sugar-making. *Agricultural Journal of India*, Vol. V, page 39.

(polarising 98·4 as against Hadi's 95·1), the factory efficiency factor being 66 as compared to 55·4. The sugar left in the molasses is 18 per cent. as against 19·6, and the amount lost in scums and destroyed in manufacture, 16 per cent. as against 25. This will be admitted to be a considerable step forward, especially as the sugar produced finds a ready market.

A reference to the table shows, however, that these results do not compare so favourably with those obtained in large central factories in other parts of the world. How far this is due to the factory itself and how far to the quality of cane used is difficult to say. A reference to Appendix A will, however, show that the juices obtained at Allahabad contained a very high percentage of glucose, the average glucose content for the first day's working was 2·06 per cent. and for the second day 2·7 per cent. This was partly due to the age of the cane, which had been brought a considerable distance by rail and road, and also to the fact that it was not obtained from a good cane-growing district, nor was it from either of the best varieties of U. P. canes.

A word or two of criticism as to the figures given in the above table for the Muscovado process will not be out of place. These were taken from a paper by Douglas written with the object of showing the possibilities of central factories in Barbados, and he has consequently given the best obtainable results for the Muscovado process. The cane juices obtained in Barbados are recognised to be unusually pure, and several contemporary writers have attributed to this cause the fact that the Muscovado process lasted in Barbados long after it had been replaced by modern central factories in the neighbouring colonies of Trinidad and British Guiana. With impure juices the Muscovado process gives a much lower sugar recovery. It does not differ in any *essential* detail from the Indian *khandsari* process. It may be added that the Muscovado process produces sugar of a very low purity (polarising 90 per cent. and under) which has no counterpart in the Indian market, and which further loses weight considerably by drainage. This explanation is necessary as the figures given in the table would otherwise lead to the erroneous

PLATE XXXVII



A. J. I. THE SUGAR ELEVATOR, DRYER, GRINDER AND SIFTER

conclusion that the Muscovado process is much more efficient than the Hadi process and about as efficient as the small plant described in this note.

With reference to the figures quoted for larger central factories, it has already been noted that these are largely influenced by the purity of the juices worked with. It should also be remembered that most of these factories turn out a large proportion of their sugar in the form of refining crystals and not as white sugar for direct consumption, thus increasing the *apparent* efficiency of the sugar recovery. It is, of course, not contended that in a small factory of this description the same efficiency can be obtained as in a large central factory.

Lack of time prevented any detailed chemical examination of the different stages of the process. The results, however, although they must be accepted with some reserve as already explained, indicate roughly in what direction further improvements are possible. The percentage of sugar lost in manufacture was very high for a modern plant, and there is some reason to believe that a considerable quantity of this was due to mechanical losses in the scums. With purer juices less sugar would be left in the molasses.

Percentage of sugar recovered from the cane.

The figures given above are based on an exceedingly short trial covering only three days' working, and, consequently, are given with some reserve. In view, however, of the fact that conditions at Allahabad were uniformly less favourable than would be obtained in normal working in a good sugar district, they may probably be considered to be on the safe side. No direct tests having been made as to the recovery of sugar from the cane, it is with some hesitation that one expresses any opinion on this point. Assuming, however, an extraction of 66 per cent. (which was obtained in actual practice as an average of two tests) and a juice containing 16 per cent. by weight of sucrose (average of the second day's working was 16·29 per cent.), this corresponds to 6·97 per cent. of sugar recovered from the cane. This figure

is fortunately confirmed by a previous test in which the cane entering the factory and the sugar produced were carefully weighed, although no analytical control was possible at the time, and in which as a result of four full days' working a recovery of 7 per cent. on the cane was obtained. In actual factory practice this figure will vary considerably with the quality of cane obtained, but the figure given above indicates approximately what may be expected. With careful cultivation and selection of only ripe canes for manufacture considerably better results are possible. Too much stress cannot be laid on the importance of pure juices to a factory, for the losses of sugar during manufacture due to the presence of glucose and salts in the juice, and hence in the massecuites, are generally recognised to be exceedingly heavy. It has been shown, however, by Clarke* that with proper cultivation and harvesting exceedingly pure juices can be obtained from some varieties of indigenous canes. While it is doubtful how far the exceedingly pure juices obtained by him on an experimental scale could be reproduced on a commercial scale, there is every reason to believe that Indian canes with proper cultivation can produce juices not inferior to the world's average in sugar content and purity.

III.—FINANCIAL RESULTS.

When the exhibition factory was arranged for, it was hoped that it might be possible to publish a balance sheet for the season's working, which would give a fair account of what might be expected from a small modern factory. So many disturbing factors, however, arose in working the factory purely for exhibition purposes that any such balance sheet would be misleading. To mention only three of these: (1) cane cost double as much as it does in a sugar-growing district and reached the factory stale, besides often being inferior in quality; (2) the price of labour during the exhibition was exceedingly high, and (3) the necessity of providing demonstrations at suitable hours every day made it impossible to work the full twenty-four hours under

* Proceedings of the Agricultural Conference, Allahabad, January, 1911.

normal factory conditions. The tentative statement given below, however, is based on the experience obtained at Allahabad :—

Capital Cost	Rs.	
Cost of the plant and staging	36,000	
Cost of erection about	2,000	
Cost of buildings (variable)	4,000	
		42,000
Working capital (cost of season's cane)	12,000	
Miscellaneous	1,000	
		55,000
Interest and depreciation and maintenance on Rs. 42,000 at 20%	8,400	
Interest on Rs. 13,000 at 8	1,040	
Cost of cane for 80 days' working at As. 4 per maund ...	11,760	
Supervision and skilled labour at Rs. 760 p.m. for three months	2,280	
Labour at Rs. 200 p. m.	600	
Contingencies at Rs. 100 p. m.	300	
		24,380

80 working days at 40 maunds per day = 3,200 maunds of sugar; consequently the cost of production of one maund of sugar is Rs. $\frac{24380}{3200}$ = Rs. 7-10. In addition about 1,000 maunds of molasses would be produced for which there is usually a ready market.

The supervision charges are calculated as follows :—

	Rs. p. m.
European Manager (who would be a trained sugar boiler) ...	350
Assistant Manager (Indian)	100
2nd Assistant (Indian)	60
Skilled labour—two mechanics at Rs. 30 each	60
Two stokers at Rs. 15 each . ..	30
Four filter and centrifugal men at Rs. 15 each	60
Clerk	
Weighman	15
	760

Similarly, if the price of cane is As. 5 per maund, the cost of production of one maund of sugar rises to Rs. 8-8-6 per maund and with cane at As. 6 per maund to Rs. 9-7-4 per maund. No assumption has been made so far with reference to the selling price, but assuming that sugar fetches Rs. 10 per maund and molasses Rs. 2 it is obvious that the factory can show a reasonable profit for its season's working even with cane at As. 6 per maund. Cane is frequently available in these provinces at As. 4 per maund

or less, but it must be remembered that with an outturn of 400 maunds per acre, which is probably a fair average, this yields only a moderate profit to the grower and one which would not invariably induce him to grow cane for a factory. On the other hand, a factory paying As. 6 per maund would probably find that cane cultivation in the vicinity would increase.

A liberal allowance has been made for working capital and for interest on the same terms as advances have usually to be given to secure the cultivation of any considerable area of cane. When advances are made, the cane is, of course, purchased cheaper. In the above statements I have only assumed a working period of 80 days or including stoppages three months. It should be possible by judicious arrangement of the cane supply to arrange for a working season of 100 days; this depends on circumstances beyond the control of the factory manager, and the question of the selection of early and late ripening varieties of cane is all-important in this connection.

The main difficulty, however, in running a factory on these terms is that the staff is only employed for three months in the year. Equally of course depreciation and interest has to be paid on the plant and capital for a whole year. This is a difficulty that occurs in all cane-sugar factories, but is accentuated in these provinces where the possible cane harvest is shorter than in almost any other sugar-growing country. The effect of this as regards depreciation has already been allowed for, but practical difficulties occur in the case of the staff. A European manager is at present a *sine qui non*, and if he is to be retained from year to year, it would be necessary at least to pay his return passage to England, his pay on the voyage and probably a small retaining salary. This would be practically equivalent to three months' salary. A similar difficulty arises as regards the Indian assistant managers. Under these conditions, therefore, supervision charges would be raised by about 1,000/- to 1,500/-, raising the cost of production by from 4 to 6 per cent. At present, however, an alternative offers. Sugar can be made in the off season from *gur* provided that a supply of *gur* is obtainable at a reasonable price

and of a suitable quality. *Gur* of good quality for sugar-making was available during the present year at Rs. 3 per maund landed at Allahabad or Cawnpore in some districts it was considerably cheaper. Actual experiment with about 10 tons of *gur* showed that the factory as it stood was capable of handling *gur* economically. For regular working one or two minor additions for convenience sake would be necessary. From the *gur* used about 40 per cent. by weight was recovered as marketable sugar. Thus *gur* at Rs. 3 per maund corresponds roughly to cane at As. 8, a price which the factory could afford to pay if it could work most of the year.

Gur as a starting point for sugar-making is admittedly scientifically unsound : the loss of sugar during the manufacture of *gur* is very high indeed, and it is at the best an indifferent material for sugar-refining. It has, however, the advantage of being available in large quantities, can be transported for considerable distances and can be stored. The price of *gur* in the Indian market apparently bears little relation to the price of imported sugar, or to its own sugar content : the higher-priced *gurs* prepared for eating purposes are so dear in proportion to their sugar content that they are entirely useless for refiners who require *gur* that has been limed in preparation. Nevertheless from statements made by land-holders in the U. P. visiting the factory at Allahabad, it appears probable that, for some years to come at any rate, many of them will be in a position to obtain *gur* for refining purposes at reasonable rates, and this affords a method of employing the factory and its staff for the greater part of the year. The following statement gives an approximate estimate of the cost of working a factory with *gur* during the off season :—

	Capital cost. Rs.
Plant and staging as before	36,000
Erection	2,000
Buildings	4,000
Extra plant for handling *gur*	1,800
Working capital ...	20,000
	63,800

		Rs.	
Establishment (as before) Rs. 760 per mensem	...	9,120	
Labour Rs. 200 per mensem ...	... ...	2,400	
			11,520
Interest and depreciation, and maintenance on Rs. 43,800 at 20 per cent.	... ...	8,760	
Interest on 20,000 at 8 per cent.	. ...	1,600	
Repairs and miscellaneous expenses	... ..	1,000	
			11,360
Purchase of cane. 80 days' supply. at As. 6 per md	...	17,140	
Purchase of *gur*. 200 days, at Rs. 3-12 per md.	...	75,000	
Fuel in addition to megass (for *gur* working only)		3,000	
			95,140
			1,18,020
INCOME—			
Sugar from cane. 40 mds. per day, 80 days. 3,200 mds at Rs. 10	... ...	32,000	
Sugar from *gur*. 40 mds. per day, 200 days. 8,000 mds. at Rs. 10 ...	. . ...	80,000	
Molasses. 8,000 mds. at Rs. 2	... ..	16,000	
			1,28,000

Nett profit after paying interest and depreciation Rs. 10,000.

In this estimate it will be noticed that I have taken high rates for both cane and *gur*: with cane at Rs. 4 and *gur* at Rs. 3, the profits would be increased by Rs. 20,000. On the other hand, a reduction of the price of sugar to Rs. 9 per maund with cane and *gur* both dear would mean that the factory would only just pay expenses, interest and depreciation. This combination is unlikely, but would have to be faced in individual years. It must also be admitted that unless both *gur* and cane were cheap, the factory could not possibly compete with imported sugar. With cheap cane, cheap *gur* and advantage of being near its customers it might just do so. With *gur* at Rs. 3 and cane at As. 4 the working expenses would be Rs. 97,640. If sugar sold at Rs. 8 per maund, there would be a profit of Rs. 8,000 (after paying interest and depreciation) provided that the molasses market held good.

It has been the custom in certain quarters to estimate the possibilities of factories by calculations based on the present price of *desi* sugar (about Rs. 12 per md.). That some small

factories do obtain these prices is undoubted, but it is also a fact that large factories working in Behar obtain much lower prices. If the sugar industry in India is to extend, it will be by replacing sugar at present imported. There are a number of consumers willing to pay higher prices for *swadeshi* produce and others apparently who are willing to pay an intermediate price for sugar made in India, but who are not willing to pay the high price at which sugar produced by the old *khandsari* process is sold. Any factories, however, starting in the near future will apparently obtain a considerable advantage for some time, no small matter if it enables them to pay off their capital liabilities before severe competition sets in.

In conclusion, it may be stated that the results given in this report can only be treated as a first approximation. Messrs. Blair, Campbell & McLean have shown that there are no great practical difficulties in constructing a small factory capable of dealing with the produce of 100 acres per annum, and that without using any chemicals, or any process objectionable to the most orthodox Hindu, a sugar suitable for direct consumption and commanding a good price can be produced. A short control test has shown that the factory is considerably more efficient than any other factory of its size tried up to the present. The results also indicate in a general manner in what direction future improvements might be expected. Definite conclusions on this point can, however, only be obtained by a season's working under normal conditions and under careful chemical control.

It is, of course, impossible in actual practice that so small a factory should work under chemical control. It would necessarily have to work largely by "rule of thumb." Until, however, the possibilities of the factory have been thoroughly investigated, chemical control is essential.

If small modern factories are to play an important part in the development of the sugar industry in the United Provinces, the question of training suitable men for managers and assistant managers will become a serious problem. At present a European sugar boiler is necessary. Suitable men are not easy to obtain,

are relatively expensive, and they vary very much in capacity for independent work and for controlling labour. There seems, however, no reason why Indians of good general education should not be trained in sugar-boiling and factory management as well as in sugar-engineering. Practical training in a factory would be essential, combined with sufficient instruction in the principles involved to enable factory managers to meet difficulties which call for a departure from the ordinary routine.

In conclusion, it cannot be too strongly emphasised that whilst it has been shown above that a very small factory can be worked at a profit, the largest commensurate with the available cane supply should be installed in every case. The larger the factory, the smaller the proportionate capital cost and the greater the *possible* efficiency and the better the supervision which can be afforded.

The writer wishes to express his indebtedness to the Agricultural Chemist to Government, U. P., who kindly lent an assistant, Babu Har Narain, for the analytical work and to Mr. Hulme representing Messrs. Blair, Campbell and McLean, for the facilities given for the examination of the factory and for the ever-ready courtesy with which any information required has been supplied.

Appendix A.

Analyses of cane juice.

1st day No.	Sucrose in juice.	Glucose in juice.
1	15·70	2·48
2	16·12	2·28
3	16·70	1·88
4	17·12	1·62
5	17·02	1·71
6	16·94	1·87
7	16·92	1·88
8	16·62	1·78
9	16·53	2·03
10	16·87	1·81
11	15·83	2·30
12	15·82	2·57
13	15·77	2·32
14	16·32	1·90

Appendix A. (*Continued.*)

Analyses of cane juice (Continued.)

1st day No.	% sucrose in juice.	% glucose in juice.
15	15·68	2·46
16	15·49	2·45
17	15·27	2·12
18	16·43	1·68
2nd day 19	16·33	1·91
20	15·91	2·02
21	16·00	1·96
22	15·40	2·36
23	15·35	2·41
24	15·68	2·33
25	15·96	2·35
26	15·63	2·43
27	15·96	...
28	15·10	2·71
29	14·70	3·71
30	14·00	3·56
31	14·[illegible]2	3·26
32	13·56	3·39
33	13·87	3·48
34	14·02	3·41
35	14·08	3·52
36	12·45	3·82

DIFFICULTIES IN THE IMPROVEMENT OF INDIAN AGRICULTURE.

By M. E. COUCHMAN, I.C.S.,

Director of Agriculture, Madras.

At the sixth Annual Session of the South Indian Association, Madras, Mr. M. E. Couchman, I.C.S., Director of Agriculture, Madras, read a paper on "Difficulties in the Improvement of Indian Agriculture." He said: -

"The object of this paper is to allay the impatience which finds occasional expression that more rapid progress is not being made in the improvement of Indian agriculture. This criticism comes from the educated classes. The general attitude of the agricultural classes towards the department is still that of the landholders of another province, who, when summoned to meet the head of the province in conference and asked what their wants were in agricultural matters, replied more land, more water, and to be left alone by the Government.

"I have, therefore, taken advantage of your invitation to place before you as the representatives of the educated classes of Madras some of the reasons why progress in the introduction of agricultural improvements must always be slow, and especially so in India.

"In doing this, I shall not dwell upon the ordinary administrative difficulties which impede all branches of Indian administration and especially those which seek to remove long-standing prejudices or to change old customs and have to rely only on persuasion to achieve their objects. You are familiar with all these difficulties. You know the dislike and suspicion of official interference which are still so strong in the villages. The Tamil proverb that a village which is often visited by the king will

never prosper, is still representative of the ideas of the average villager. It is easy to make too much of these difficulties; although we have but a very small establishment as yet, we find that a properly trained and sympathetic subordinate who really knows his business can, without very much difficulty, gain the ear of the cultivating classes and persuade them to try our suggestions, provided he has some real improvement to recommend to them. The difficulties which I shall try to describe to-day are those of general application fundamental to the subject.

"In Tolstoi's great book, Anna Karenina, there is a vivid description of the various hindrances that an educated man meets with when he tries to influence his tenants to adopt what seem to him more up-to-date methods of agriculture.

"Constantin Levin bought a hay-making machine. The man who drove it disliked the long arms of the machine waving over his head, and took steps to put it out of order. He bought English ploughs, but his peasants broke them because they were too lazy to lift them up when turning at the end of the furrow. He imported English cattle but they were suffered to die for want of ordinary attention. He set apart a portion of a field for seed, but his men cut this before it was ripe, because it was the easiest to cut. In another of his books Tolstoi lays his finger on the right place, when he says that an agricultural reformer must first study the mind of the peasant, because this is the most important of all agricultural conditions, and it is this which we must study before we consider the other elements of the problem.

"Superficial observers in all countries are in the habit of deriding the farming classes as ignorant and obstinate, blindly following the obsolete practices of their forefathers and inasmuch as farmers seldom write books, judgment goes against them by default. I should like you to consider for a moment why it is that farmers as a class are more conservative than the rest of the world and whether they are wrong in being so.

"A farmer is brought up on the land from his earliest days. Year after year he witnesses the same majestic procession of the seasons. The same crops are sown and harvested at the same

times. Every act of his life is guided by the regular and unvarying movements of nature, and the farmer himself may be said to be a part of nature's system. It is far otherwise with the physician, the lawyer and the merchant. They have necessarily to study the fickle thing by whose favour they live, human nature with its thousand varying moods and fancies. Their minds are, therefore, necessarily always on the alert for signs of change. One year a doctor must, if he wishes to be popular, recommend the operation for appendicitis. Another year he must insist on the virtues of the Bulgarian milk bacillus. The piece-goods merchant knows that the pattern which sold last year may be out of favour this year. There are so many lawyers here that I should be afraid to give specific instances from that profession, but I believe I am right in saying that different clients require different handling and, with due respect, the same may be said of the judges themselves. It is, in fact, our occupations which mould our characters, and the occupation of a farmer is such as to make him a conservative. Looking into the matter more closely, we must admit that very often change is uncalled for in agricultural methods. It is contrary to human nature to expect the average man to incur exertions in excess of what suffices for his needs. So long as he can live comfortably on the scale demanded by his standard of living, there is no need for change. Life in many parts of India is still so simple that over large tracts there is no call for agricultural improvement. The need for improvement only arises because even the remotest villages are connected up with the outside world, which is always changing.

"To foresee the need for change, to recognise the slight indications which herald its advent, requires not only a scientific training but very special gifts of insight and imagination. A common error is to suppose that because the peasant gives an absurd reason for rejecting a proposed change in his methods, his opposition to it is irrational. He may know by instinct that the suggested improvement is no improvement at all, because it is out of harmony with his general system of cultivation, but he

would never be able to express this idea and hence gives the first reason which comes into his head. Most of the critics of the farmer's conservatism are ill-equipped for the task of setting him right, and every language probably has old stories, the moral of which is that the man who listens to his neighbour's advice comes to a bad end.

"One difficulty, then, common to all countries is that the farming classes are necessarily conservative and are usually right n being so. When, therefore, we have a real improvement to ut before them they are apt to turn a deaf ear.

"This difficulty is present in a special degree in India where ot only are all classes more conservative than in the West, but he separation between the educated classes and the agricultural lasses is more complete than elsewhere, resulting in a want of nowledge on the one side and of confidence on the other. The gricultural department has a double task to overcome this ifficulty. It has to try to interest the agricultural classes in ducation and the educated classes in agriculture.

"Only second to the difficulty of overcoming the conser-atism of the farmer comes the difficulty of finding improvements which can be safely recommended to him. Occasionally the xample of the agricultural departments of other countries s held up to us for imitation. It should be remembered hat the agricultural department of a country like America r Africa has an easy task before it compared with ours. n those countries the farmers are still opening up virgin land, r only just beginning to feel the need for intensive cultivation. he experts of the department have the experience of older coun ies to guide them in their work. The farmers of new countries re many of them not professional farmers at all but adventurous pirits who have been attracted to the new country by a love of lventure or the hope of making a fortune. They are, therefore, n need of advice and are anxious to have it. Moreover, the ail-ents of youth are easier to cure than those of age. The agri-ultural experts of those countries may be compared to physicians reating a child for a case of measles. In India we are prescribing

for a patient of advanced age suffering from general debility. The farmers of this country have behind them the experience of thousands of years of cultivation and have therefore learnt all that actual experience can teach them. There is nothing new in this country. We have lately been told that even aeroplanes were known in India long ago. It is a fact that painful experience has already taught nearly all that there is to learn about the seasons and the management of the soil, though by no means all the cultivators follow their better judgment. This knowledge is unevenly distributed, and one task of the department is to introduce good practices from one part of the country into another. Another field of work, of course, lies in those matters where physical science has discovered facts which the experience of practical farmers could never come across. The field of possible improvement is, however, far narrower than in new countries and progress must, therefore, be slower. I may, however point out that in countries where politics enter into agriculture, the reports of the agricultural department cannot safely be taken at their face value. We do not know what the farmers of those countries really think about them. Another very important point the force of which will be felt more and more, as soon as we have come to the end of the few obvious improvements which can be discovered without any research, is that all scientific agriculture, and all agricultural literature up to the last few years, deals with the agriculture of temperate climates, and is founded on research work done outside the tropics. Hence in India we have to throw away almost all our knowledge of applied agricultural science, and fall back on first principles, and work out our proposed improvements from the beginning. For example, many of the methods, which farmers follow in England for cleaning the land and preparing the soil to receive the seed, are based upon the effects of the severe European winter, and quite different methods have to be worked out here. As regards research, the number of scientific men in India is so small and so much of their time is at present taken up in work of organisation and teaching that little time remains for research. We must have patience till we have

produced an Indian school of agriculture with a numerous body of workers. It is seldom that any great discovery is made at one step by one man. The competition and co-operation of many men devoted to the same studies is necessary before much progress in agricultural research can be expected. We must learn before we can teach. Many years of research and experimental work will be required before we can fully understand the agricultural practices of Indian cultivators, and till we do understand them, any improvements we may be able to make in them will be due more to good luck than to a solid foundation of real knowledge.

"I may then sum up the chief difficulties which hamper the progress of agricultural improvement, as, first, the want of knowledge regarding Indian agriculture. Second, the fact that in India so much practical knowledge has already been discovered by the experience of generations that there is less scope for a rapid advance than in new countries: and thirdly, that the Indian cultivator possesses in an intensified form the conservatism of the farmer common to all countries, and that, owing to the separation of classes here, the difficulty of breaking down that conservatism is greater here than elsewhere. The last difficulty, however, is the least of the three. Our experience is that the Madras cultivator is by no means unwilling to take up a new thing if it is really an improvement. The rapid spread of Cambodia or American Cotton in Tinnevelly, Ramnad and Madura districts in the last few years is a most encouraging sign that a really good new crop can be introduced very rapidly.

"For introducing such improvements as can already be safely recommended we need more trained men. To remove the difficulty of want of knowledge, we want more workers in the field of research. Ample facilities have been provided for both purposes at Coimbatore. As I have pointed out on a recent occasion, the prospects from a pecuniary point of view are not to be despised, especially when it is remembered that the department is a new and expanding one. For a man of means who is on the look-out for an interesting and useful career I cannot imagine one which has more attractions.

"What I would ask our critics to bear in mind is this. It is far from easy to point to positive improvements suitable for any particular village without knowledge of the locality. We are often pressed to send itinerant lecturers broadcast through the villages, and it is assumed that qualified lecturers are to be had at a moment's notice and that agriculture can be taught by lectures in the same way that law or arithmetic is taught. Agriculture is an applied science, and its application must vary in a greater or less degree with every small variation of local conditions. Lecturers on the general principles of agriculture would be useless to ryots who are not used to deducing their practice from theory. The only thing which appeals to them is definite advice. If a new crop is to be recommended to them, the exact kind of soil suitable for it, the exact time to sow it, the exact method of cultivation must be laid down, and if the advice given is, owing to any special circumstances in the village, impracticable, the cultivator will conclude that his would-be adviser does not know his business and will not listen to him.

"And it is absurd to blame him for this attitude. He cannot afford to engage in an experiment. You will see, therefore, how it is not possible for a lecturer to start to-night from Mylapore and lecture to the ryots of Ganjam on paddy cultivation if he has not been there before and does not know the local practices and seasons. We must in short learn before we can teach, and we must not blame the cultivators if they are somewhat hard to persuade. Time and patience will overcome both difficulties. The essential thing is to avoid giving ill-considered advice which would retard all progress indefinitely."

PLATE XXXVIII.

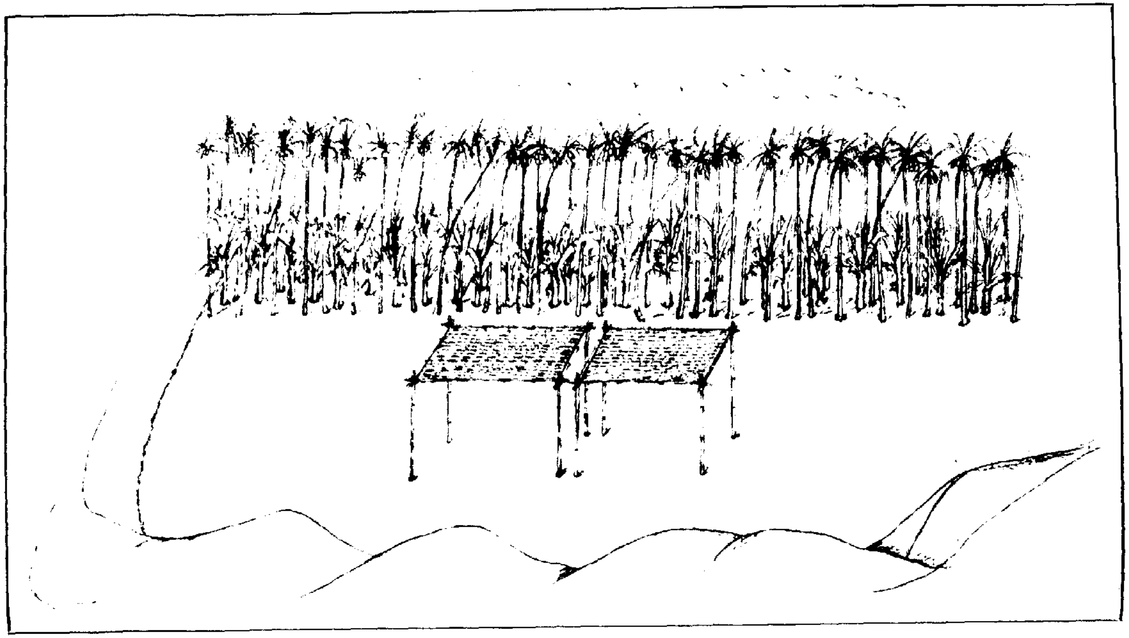


Fig. 1.

THE DRYING OF PLANTAINS AT AGASHI.

By L. B. KULKARNI, *L. Ag.*,

Of the Bombay Agricultural Department.

AGASHI is a village in Bassein Taluka, Thana District, Bombay Presidency. It is about twelve miles from Bassein and one mile and a half from the sea. There is a continuous range of hills to the north. Fields of plantains bordered by cocoanuts, are seen to the south of the village. Between the hills and the cultivated lands there is a small plain and on this plain the plantains are dried. The place visited is shown in figure 1. The drying process of plantains begins in October and lasts up to the end of December. During this period the maximum and minimum temperatures are as follows :—

	Max.	Min.
October	... [illegible]	[illegible]
November	... 89°	70°
December	... 82	67

Four varieties of plantains, *e.g.*, *Basrai*, *Mutheli*, *Welchi* and *Rajeli* are grown here, but all are not used for drying. The special variety dried is *Rajeli*. This variety is distinguished from the rest by the following points. The plant grows about 13 feet high : it is next in height to *Welchi* which grows up to 15 feet. The plantains are from 6″ to 12″ long. One typical raw fruit is shown in the figure 2. The fruit has three distinct ridges. The pulp is very tough to the touch, and on it there are found six lines. The diameter of the pulp is about an inch. Mr. G. A. Gammie in his "Field, Orchard and Garden Crops" of

the Bombay Presidency" (page 72) gives the following description of the *Rajeli* plantain :—

"Robust, stem yellowish green, leaves long and narrow; fruits usually five inches long by 1" to $1\frac{1}{2}$" broad: yellow, more or less plano-convex: gradually narrowing to the stalk. Lip contracted with a distinct hard brown beak."

This variety is not treated differently from the others as regards cultivation. The suckers are planted with other varieties in October at 6 feet distance. Water is given twice a week. Castor cake, three pounds per plant is given. The first manuring is generally done after the plants take hold of the soil: the second one month later. The fruits are ready for harvesting in the October of the following year.

Harvesting.—The heads are removed when the fruits attain their full size. It needs an experienced eye to tell when this stage is reached. The fruits look quite green when the bunches are cut. The newly cut bunches are brought into the houses, and there the peduncles are removed. The small bunches are put in a store prepared by cylinders of a bamboo mat 10′ × 10′ placed vertically. This store is generally in the centre of the house and thus the entrance of air is prevented as far as possible.

On the floor of this improvised store house rice straw is placed and on it the plantain bunches are spread layer by layer. The topmost layer is covered by plantain leaves to produce heat. One store like this accommodates about 12,000 to 15,000 plantains. They are generally stored in the morning and are taken out after three days. The colour of the fruit is then quite yellow. A typical fruit ready for drying is shown in figure 3. The fruit when ripe is diminished in size.

The ripe bunches are brought in a basket to the prepared ground on the plain outside the village. The ground is made hard by beating it with a wooden plank and then plastering it with cowdung and water. A mat about 6′ × 8′ is spread on the prepared ground when it is dry. Then the plantains are arranged in a line after the skin has been removed. The colour and the appearance of the fruit on the first day is shown in figure 4.

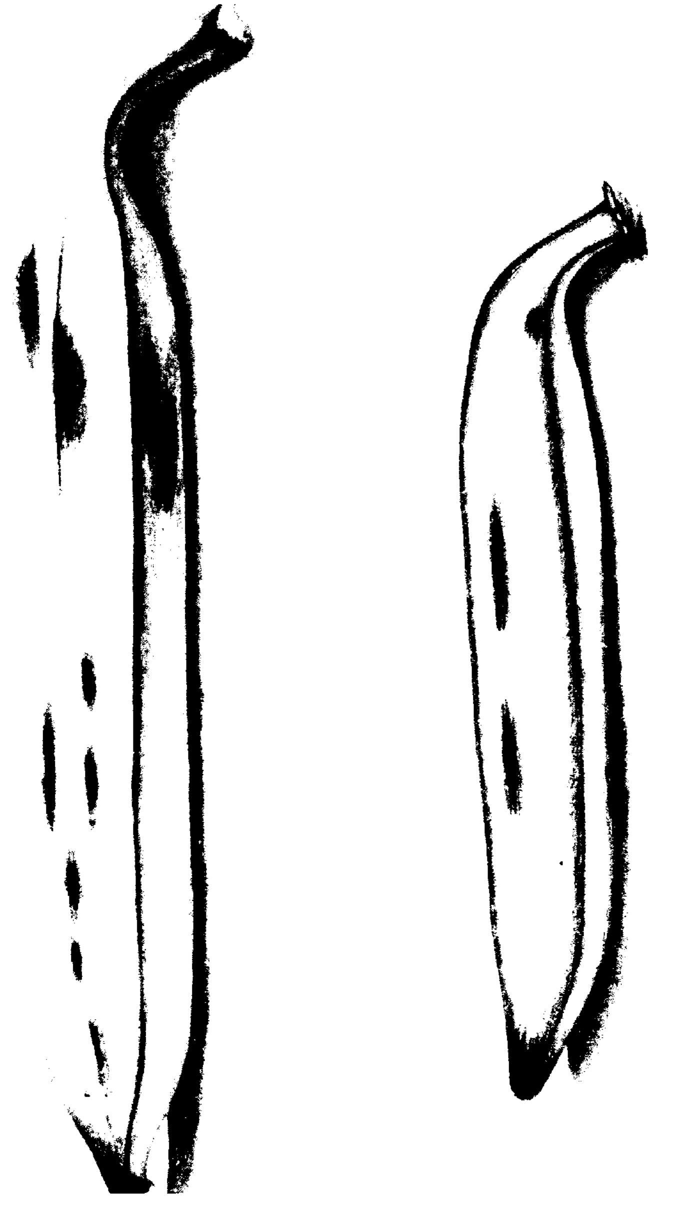


PLATE XL.

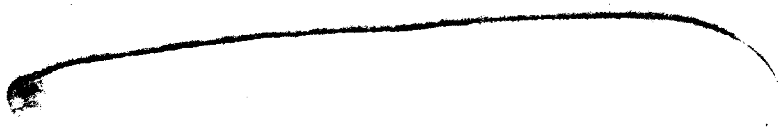


Fig. 4.

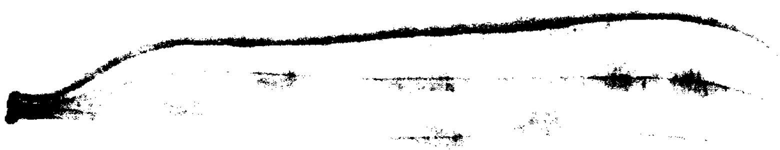


Fig. 5.

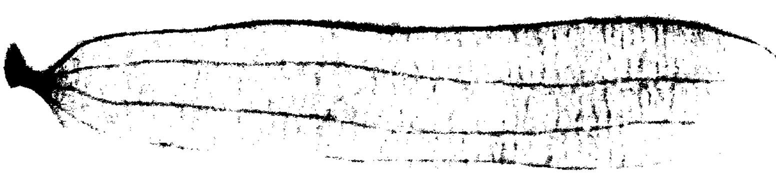


Fig. 6.

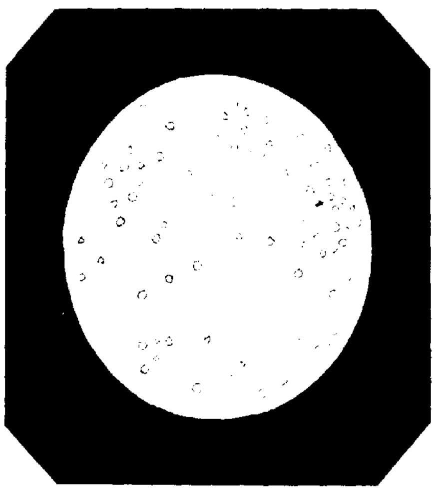
Fig. 7.

Some people dry the plantains on a platform about 10 feet high to avoid the trouble of watching.

After lying all day in the sun the fruits are gathered in a heap in the evening before the cold begins and are left all night covered with dry plantain leaves and a mat. The above processes are repeated for three days and three nights, and on the fourth day the fruits are ready for marketing. The figures 5, 6 and 7 show how the colour changes from day to day. The fruit is, before drying, very hard to the touch, brittle and round; but as it dries, it becomes yielding to the touch, elastic and flattened. It also loses some weight. The fruit tastes sweeter as it dries. It is said that properly dried plantains keep for six months. On the last day of drying the fruits are wrapped in plantain leaves in bundles of a dozen each. The retail rate is about four annas a pound, and the wholesale is 3½ annas according to the quality of the fruit and the state of the market.

The yearly yield of dried plantains from Agashi is estimated at 160 tons, worth about Rs. 27,000. It is said that plantains used to be dried at some other villages than Agashi (Thana Gazetteer, p. 292), but it does not seem to be done nowadays except at Agashi. The cause of this is not known.

them in fresh water for nine months, the water being changed once a week. After nine months they appeared like a white powdery sediment. Under the microscope a drop of it showed innumerable polyhedral bodies. The under-surface of some mulberry leaves was stained with these polyhedral bodies (by means of cotton soaked in them) and some worms were fed with them; within five or six days 30 to 35 per cent. of the worms died of grasserie. The *Antheræa Pernyi guer-men* of China and *Antheræa Yamamai Guer-men* of Japan, which feed upon the leaves of *Quercus Serrata Thunb*, when attacked with grasserie, show some triangular bodies, and not polyhedral ones, which vary in size according to the size of the silk-worms. But the *Attacus ricini* of Assam, when attacked with grasserie, show polyhedral bodies,



TRIANGULAR AND RECTANGULAR BODIES OF GRASSERIE IN ANTHERÆA YAMAMAI AND ANTHERÆA PERNYI.

bigger in size than those of silk-worms. According to some these polyhedral bodies are crystals. It is, however, more probable that they are crystalloids which can be dyed when dipped in such re-agents as Gentian violet, Safranin, Borax carmine, etc., for 12 to 16 hours. Crystals cannot be so dyed. Besides, when these bodies are crushed, 6, 7, or 8 irregular

angles are visible in them, unlike those of crystals. They are formed in the fatty tissues in the hypodermal layer, and in the tracheal membrane of the silk-worms, and in their undeveloped stage they remain in a cyst or bag in the body of the worms where they grow by division in large numbers.

As to the true cause of this disease opinion differs: some are of opinion that the polyhedral bodies are the true cause of grasserie; while others hold that when worms are infected with this disease, innumerable minute organisms (*Chlamydozoon Bombycis* of Professor Flowachek of Germany) are visible adhering to the polyhedral bodies, and that these are the true causes of the disease. Whenever I took a little membrane from the tracheal region just opposite the spiracles and stained them with different re-agents, I found these organisms; and when I separated them from polyhedral bodies, brought them up on nourishing media and fed the worms with leaves stained with the media, I found the worms infected with grasserie. I, therefore, conclude that this micro-organism is the true cause of the disease and that the polyhedral bodies are only a by-product.

I have stated already that when I fed the worms with the polyhedral bodies only (not the juice), they were also infected with grasserie. This seems inconsistent with the conclusion just stated above, but in its support it may be said that some of these organisms might have been adhering to the polyhedral bodies, and in this way might have carried the infection

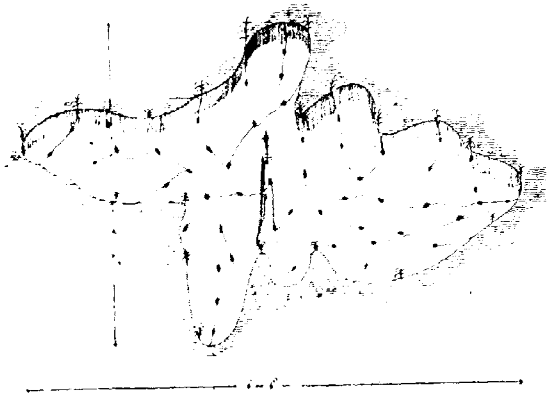
NOTES.

Note on the Life History of certain Weeds :—*Lavala* (Cyperus rotundus). Studies were begun of the life history in September 1909, beds 12′ × 12′ were planted with bulbs. These were dug up at appointed intervals and observed as below :—

A plant dug out after four months was found to have occupied a space of about one foot diameter. The maximum depth to which a plant had penetrated was 9 inches. During the period of four months it had produced five bulbs. One of these had sent up a plant and one more had sent up a shoot just reaching the surface. The distance between two bulbs varied from 10″ to 12″ and where the shoots were beginning to appear the distance between it and the bulb previous to that was from 4″ to 5″.

After eight months the development of another plant was completely traced out as follows : It was observed that the main plant sent out two main lateral runners underground, each of which formed a bulb in its course at every 9″ to 12″. The first bulbs of the two main runners gave out shoots above ground, which eventually developed into a plant. The plant produced in all nine bulbs of which six were on the right and the rest on the left. The second bulb on the right had produced a still deeper secondary runner having a bulb at its end. It was also observed that each successive bulb was formed deeper and deeper so that the last bulb was 18″ deep from the surface. It had occupied a space 58″ long and 1 foot wide. The deepest feeding root which was given out from the first bulb on the right side was measured to be 18″. On the surface of the runners scales were found.

At the end of the year another plant was dug up to further study the development. The following is a rough sketch of the plant.



From the above figure it will be seen that one plant has produced 53 bulbs and 20 new plants excluding the original. The distance between each bulb was from 4" to 9". There were two main runners—each of which has given out several secondary and tertiary runners. It was found that the deepest bulb was one foot deep from the ground level. Below this depth there was limy soil and no bulb was found penetrating this layer. The area occupied by the plant was about 20 square feet.

Haradi. (Cynodon dactylon.)—A plant was dug up after eight months and was found to have three main shoots, the longest of which was 3' 3" with twelve branches. The distance between each node was 1" to $1\frac{1}{2}$" and there was a branch at every node. The whole plant occupied an area of five square feet ($2' \times 2\frac{1}{2}'$). The maximum depth to which it had penetrated was 17".

Kunda. (Andropogon intermedius).—One plant was dug up after eight months. It was observed that it had produced underground stems which grow both deep and side-wise. The stems in several cases had branches producing palmlike branches up to ten, which branched and rebranched also individually and tended to come up to the surface. The underground runner was covered

with very closely set scales. Depth of feeding roots 14″. Area occupied by a plant one square foot which was entirely covered by the plant.—(G. K. KELKAR.)

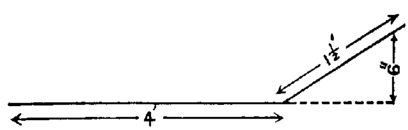
*
* *

EXPERIMENTS WITH GROUNDNUTS IN THE BOMBAY PRESIDENCY. On various farms of the Bombay Agricultural Department, experiments with the groundnut crop have formed an important feature of the work in recent years and some interesting and important results have been got in connection with the cultivation and the treatment of this important crop. To summarise the results obtained, it may be said that foreign varieties of groundnuts have been found to yield better than indigenous and some of them on account of their short period of growth escape the Tikka disease which affects the local variety. Spanish peanut is by far the most suitable variety to grow as a dry crop in places where rainfall is scanty and the season short. For irrigated crops, Senegal, Mozambique, Virginia and Pondicherry are suitable. Good yields are obtained by growing groundnut as a subsidiary crop to cotton and juar. Some varieties are heavier yielders than others. The heaviest yielders are not necessarily the greatest oil producers. So long, however, as the price continues to be independent of the oil percentage, the yield per acre of unhusked nuts will probably be the determining factor in deciding which variety to grow for greatest profit. Investigations carried out by Dr. Mann into the amount of oil in different varieties show that there is no constant relation between the percentage of oil in the seed and the variety, but that this percentage seems to be determined much more by the circumstances under which a particular variety is grown than by the nature of the variety itself.

The results obtained have been of much practical value to cultivators and the area under foreign groundnuts in the Bombay Presidency has shown a marked increase during the last four or five years. Last year (1910-11), the total area under groundnut in the Presidency including Native States was 159,000 acres which is 66·7 per cent. over the average of the preceding ten

years. There has also been an increase in the export trade since its fall in 1904-05. We cannot do better than refer those who are interested in groundnut cultivation to the various farm reports of the Presidency in which the results of these experiments on varieties, manuring and cultivation, are set out in detail.—(A. McKerral.)

The Plough Boat.—With the introduction of heavy iron ploughs into India the necessity is sometimes felt of having some contrivance to carry the plough from place to place as it cannot be carried on the yoke of bullocks as in the case of the local ploughs. In the Report of the Agricultural College Station, Poona, Bombay, a simple device made for the purpose is described:—"It is made of a *babul* plank about $5\frac{1}{2}$ feet long, 1 foot broad and $1\frac{1}{2}$ inches thick. It must be so sawn from a log of wood that $1\frac{1}{2}$ feet at one end should be inclined as shown in the diagram below:—



A catch made out of an iron strip and nailed down at about the centre of the plank completes the implement. The catch is made thus:—

The point of the share of the plough is inserted in this catch and the plough is hitched as usual. It can then be taken anywhere over stony and hilly ground with least draft and inconvenience. The whole thing will not cost more than Rs. 2."

* * *

Jowar Smut.—The efficacy of steeping *jowar* seed in copper sulphate to prevent smut was strikingly shown by an experiment

performed at the same station :—"Two plots, each four *gunthas*, were sown with *jowar*, side by side, to bring to the notice of visitors the effect of steeping against *jowar* smut. One plot had its seed steeped in 1 per cent. solution of copper sulphate for 10 minutes and the other with seed which was not treated. All other *jowar* on the farm was also steeped. It formed a very interesting and instructive occular demonstration to a number of visitors assembled on the conference day and a subsequent batch of cultivators from the Poona District was very much impressed with what they saw. This was perhaps the most conclusive and striking demonstration on the farm.

The total number of plants in each plot, with the number of plants with heads attacked by smut were counted, and the figures are given below :—

TREATMENT.	Total number of heads.	Number of smutted heads.	Percentage of smutted to total.
Steeped	5,848	16	0·27
Unsteeped	5,879	1,022	17·40

(A. McKERRAL.)

∴

THE MAIZE PLANT.—Professor F. L. Stewart, of Murrysville, Pa., has been for many years studying the possibilities of the maize plant. Ten years ago it was demonstrated that, with suitable treatment, the plant takes equal rank with the sugar-cane and the beet as a sugar-producer. Professor Stewart's theory was that, as the maize plant belongs to the same botanical family as the sugar-cane, and contains a fair amount of sucrose in its normal condition, it might be cultivated so as to increase its sucrose content up to the point where it would become profitable to work. He discovered, in the course of his experiments, that if the ears were removed at a certain period before the plant would normally cease growing, the period of growth would be increased by from four to six weeks, and during that time the anatomical structure became radically changed. The plant

increased in size and weight: the saccharine content increased to more than double its normal amount, with a purity far above that of the natural juice, while the fibre or bagasse furnished material for paper-making of a very high grade. Experiments conducted in some twenty different States during the last few years have confirmed the results obtained at Murrysville.

In a recently-issued statement Professor Stewart estimates the products of maize treated according to his process as follows:

A ton (2,000 lbs.) of corn cane produced under the Stewart patents, contains an average of 570 lbs. perfectly dry solid matter, and of this, 270 lbs. are in solution in the juice. Of this dissolved matter an average of 240 lbs. per ton is sucrose, 20 lbs. uncrystallisable sugar, and 10 lbs. organic matter not sugar. The average yield of dry crystallised sugar is—

First sugar 96° centrifugal	...	... 160 lbs.
Second sugar 89° centrifugal	...	... 30 lbs.
	Total	... 190 lbs.

About six gallons of molasses, containing about 70 lbs. of uncrystallisable sugar, remain as a by-product which is converted into ethyl spirits producing 5·18 gallons of 95 per cent. alcohol.

A ton of trimmed stalks produces, also, when milled and dried, about 300 lbs. of air dry fibre, which gives about 200 lbs of dry bleached paper pulp. The average weight of the leaves per acre is approximately one ton, and contains about 300 lbs. of air-dry fibre, or 200 lbs. of finished paper pulp.

In one ton of green ear and husk product there is about 580 lbs. of dry substance, of which 420 lbs. is fermentable matter, 85 lbs. of dry pulp and about 30 lbs. of corn gluten. The fermentable matter will yield half its weight (210 lbs.) for 31·4 gallons of 95 per cent. alcohol. In that portion of the corn belt where a suitable climate and soil can be secured, an average of twenty-five tons, gross weight, of several varieties of corn can ordinarily be grown per acre. Of this fifteen tons are stalks and ten tons green ears and husks.

To summarise, the yield of all products is as follows :—

SUGAR.

First sugar 96°—	
160 lbs. × 15 tons per acre	2,400 lbs.
Second sugar 89°—	
30 lbs. × 15 tons per acre	450 lbs.
Total ...	2,850 lbs

ALCOHOL.

From ear and husk, fermentable matter—	
210 lbs, or 31·1 galls. of 95 per cent.	
alcohol × 10 tons per acre	311 galls.
From molasses produced from one ton of corn cane—	
35 lbs., or 5·18 galls. of 95 per cent.	
alcohol × 15 tons per acre	77 galls.
Total ...	388 galls.

PAPER PULP.

Stalk and leaf product—	
213⅓ lbs. per ton × 15 tons per acre	3,200 lbs
Ear and husk pulp, 85 lbs. × 10 tons per acre ...	850 lbs
Total	4,050 lbs.

(*Journal of the Royal Society of Arts, 20th January* 1911.)

UNITED PROVINCES EXHIBITION, ALLAHABAD, "CHULA" COMPETITION.—The question of the wholesale use of cowdung or wood as fuel in India has an important agricultural bearing, so that any attempt at introducing a cheap appliance to burn coal must be of considerable interest. At the Allahabad Exhibition a "Chula" competition was held and the "Yule" prize of Rs. 1,000 offered to the inventor of the best "Chula" or stove, capable of burning raw coal. The prize was won by Mr. J. D. High, Lukergunj, Allahabad, and his "Chula" is now being manufactured and sold by the Rope Sole Shoes & Knitting Co., Limited, Allahabad. The "Chulas" are made in three sizes, *viz.*, Large, Medium and Small, selling at Rs. 14, Rs. 7 and Rs. 5, respectively.

In his note on the competition, Mr. W. R. Wilson, Director of Industries, United Provinces, remarks as follows:—

"The winning Chula is simply a cheapened adaptation of an English stove or "range:" its cost is Rs. 4-8 and it might be made stronger and more lasting, with advantage. It is very economical of fuel, for the work done. The bronze medal Chula and Mr. Apte's are on similar lines. The former has a firebrick lining to secure economy of fuel and the latter, an ingenious lining of fireclay, mud, or clay (which must be applied by hand). Both of the bodies are strong and likely to be durable. Mr. Watson's is a cheap (0-8-0) Chula and very portable (folding up like a book), it is also fairly strong. I do not think that any Chula on the stove principle can ever be free from the smoke difficulty without a chimney. The chimney carries off smoke and a clear fire is left for cooking. In a Chula after the native style the smoke will always be a difficulty. The only way to work this is to make a good "red" fire first and then start cooking. I should burn coal in the native Chula, in the above, by setting up 6 bricks, in two "courses," in the form of a , the mouth to face the wind, and putting a small iron bar grate between the first and second courses so as to be $4\frac{1}{2}$ inches above the ground."

It is reported that a considerable number of "Chulas" have already been sold among the European and domiciled communities, showing that some device of this kind was badly wanted. Apart from questions of domestic economy in the matter of saving of fuel, any arrangement which would minimise the consumption of wood, cowdung, leaves, etc., would be eagerly welcomed by those who are aware of the loss to the country that such practice entails, and it is to be hoped that the new appliance will find a ready sale.—(A. McKerral.)

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Alleged Effect on Milk of Water or Watery Food given to Cows.—It is generally supposed that it is possible to increase the quantity of milk at the expense of the quality

either by feeding cows on watery food or by causing them to drink water in large quantities immediately before being milked. Feeding of salt is also popularly supposed to make the stock consume excessive quantities of water and thus to indirectly increase the quantity of milk. To test these points the following experiments were conducted at the Midland Agricultural and Dairy College with seven typical dairy short horn cows and reported in the *Journal of the Board of Agriculture*, London, February 1911. These cattle were stall-fed during the whole of the time the experiment was in progress. Their food consisted of concentrated and dry fodders with the addition of mangolds, and at stated intervals, *viz.*, every seventh day, it was supplemented with a definite amount of salt.

The amount of water taken daily was measured by allowing each cow to drink from a graduated vessel. For the first seven days each cow had *free* access to a measured quantity of water. In the second week she was allowed to drink only just before being milked. In the third week water was free, on the fourth intermittent. Milking was regularly and expeditiously undertaken, the interval between successive milking being ten and fourteen hours, evening and morning respectively.

The cows were numbered 1 to 7, and the scheme was mapped out in days. On the first day cow No. 1 received four ounces of salt, on the second day cow No. 2 was salted, and so on. Thus one day in each week a cow received salt, and on every day of that week some one cow was receiving salt. From the experience gained in the first two weeks the experiment was altered, so that instead of giving four ounces of salt in one meal, three ounces were given after the night's milking on one day and three ounces after the morning's milking on the next day.

The result of the experiment appeared to show that periodical doses of common salt administered to cows do not necessarily cause them to consume excessive quantities of water; and that the amount of water consumed by cows has no direct bearing on the composition of their milk yield. The experiments also showed that feeding of six ounces of salt caused

purging and that even this large quantity of salt had no effect on the quantity of milk.—(EDITOR.)

* * *

STRONG WHEATS.—The wheats most in demand by Millers in England at present are those yielding a strong flour. It is, therefore, necessary to understand what is meant exactly by the term "strength," what produces it and how it can be determined. The following is reproduced from an article on the present position of the flour question in the *Agricultural Gazette* of New South Wales, February 1911:—

The term "strength" is used by the baker to express the combination of qualities which he associates with a flour of good baking quality, such as pile, texture, shape, volume, colour, and weight of loaf. It is, in fact, another name for good baking quality. In order to place the problem on a satisfactory basis, the British Home-grown Wheat Committee has arrived at the following definition of flour-strength as "The capacity to make a big well-piled loaf." Professor Wood further points out that this is a complex of at least two factors, size and shape of loaf. The definition thus stated appears to include all the qualities the presence of which render a flour of good baking quality, and to provide a clear statement of the problem presented to us.

What exactly determines this important quality is not accurately known, and the only reliable test of the strength of a flour is its actual behaviour on baking. As this largely depends on the skill of the individual, and the methods he adopts, it cannot be considered an entirely satisfactory test, and many attempts have been made to determine the cause of strength, and to devise some means by which we might be able to determine beforehand how a given flour will behave on baking. Several factors have been suggested as being responsible for strength of flour, such as the quantity of gluten, the chemical nature of the gluten, amounts of sugar, of mineral constituents, etc., in the flour; but so far none of them have provided a satisfactory solution of the problem. The only test that has proved satisfactory in our experience is the power of the flour to absorb

water—its "water-absorbing capacity," or the amount of water taken up by the flour to make a dough of the right consistency for baking. This test, though not one that can be carried out with extreme accuracy, has, with us at all events, always proved reliable, and the power of absorbing water has always been associated with good baking quality. Without asserting that this test gives the actual strength of the flour, I do claim that it is the measure of such strength, and the best proof of its reliability lies in the fact that all Mr. Farrer's strong flour wheats were submitted to this test, and were persisted in or rejected according as they gave flour of high water-absorbing power or not.

This quality in wheat is to some extent affected by environment, by the nature of the soil and climate, and particularly by the nature of the weather during the ripening period of the grain; a hot and dry summer, in which the grain, after it is formed, is rapidly ripened, always increases the flour-strength. It is, however, an inherent characteristic of certain varieties, and soft wheats, though they may become stronger under hot and dry conditions, never attain the flour-strength of the harder strong-flour variety. Flour-strength is an inherited characteristic, and can be bred for just as colour, stiffness of straw, stooling, beards, etc., can be bred for. It would appear that strength and weakness are Mendelian pairs, and the breeding of strong-flour wheats becomes, in competent hands, a certain operation, which can be regulated in the same manner as is the case with other characteristics.

Strength does not appear to be affected by manuring. Even the use of nitrogenous fertilisers, which might be expected, by increasing the protein matter, to also increase the strength, appears to have no effect on this quality.

Gluten-content.—The actual gluten-content of wheat is a matter of less importance than flour-strength. Flour-strength is almost invariably associated with fairly high gluten-content, though the reverse is by no means the case, and some of the Durum wheats, which contain up to 20 per cent. of dry gluten,

are among our weakest wheats. It may safely be said that whilst gluten-content itself is no guide to the flour-strength, still, between two wheats of the same variety, that one will be the stronger which contains the largest amount of gluten.

A high gluten-content is an almost invariable accompaniment to a dry and hot period during the ripening stage.

Colour.—As the demand for strong-flour wheat has become greater, the question of colour has assumed less importance. The wheats which produce the dazzling white flours once in demand were not those that gave high strength, but, like the Californian and the Australian wheats, were of a starchy nature, giving a weak flour.

The colour of the flour is, moreover, by no means a sure guide to the colour of the baked loaf. The very white flours often produce a loaf of a dirty grey colour, whereas those with a slight yellow tinge give almost invariably the brightest loaf.

As a rule, the strong-flour wheats give a flour which is not so high in colour (not so white), and, in order to obtain a white flour from them, patent processes have been devised for bleaching them. These processes depend, for the most part, on the action of nitrous oxide.

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MOLASSES AS A FERTILISER. In an article in the March, 1911, number of the *International Sugar Journal*, Mr. G. N. Martin, Chemist, South African Sugar Refineries, Limited, gives an interesting account of his experience with the use of molasses as a fertiliser for canes. The account as given in the author's own words is as follows:

"The experiments were carried out in 1897. A level piece of ground of homogeneous character was selected; the field divided into four equal plots; each plot of same length and breadth and equal quantities of cuttings planted.

"Plot No. 1 was cultivated in the ordinary way, receiving the usual fertiliser as employed on the rest of the estate—nitrogen 50 lbs., phosphoric acid 70 lbs., potash 50 lbs. per acre; made up

of the following: sulphate of ammonia, dried blood, superphosphate and sulphate of potash.

"Plot No. II was grown with fertilisers as above, but received in addition molasses at the rate of 600 gallons per acre.

"Plot No. III received a mixture of 400 gallons of molasses, one ton (2,000 lbs.) of press cake, and 1,000 lbs. of bagasse ash per acre.

"Plot No. IV received nothing.

"The following is the tabulated result :—

			Plant canes. Tons per acre.	Ratoons. Tons per acre.
Plot No. I	...	...	34·1	28·3
Plot No. II	...	...	42·5	31·6
Plot No. III	...	...	40·2	33·8
Plot No. IV	...	...	24·6	17·2

"The molasses was employed at the rate of 400 to 600 gallons per acre, being simply spread in the furrows, and a week or fortnight after spreading, the planting was done. The quantity of molasses produced on the estate did not allow for the whole acreage to be planted to be so spread. A very marked difference could be observed between fields (some time contiguous) treated with molasses and fields cultivated with the usual fertiliser. In a good many colonies molasses is used as a fertiliser either by spreading on the ground or with irrigation water."

Similar results are also reported to have been obtained by Mr. Boname, Director of the Station Agronomique, Mauritius, from his experiments made in 1908. Mr. Boname states in his report that "the growth is vigorous, and that it is an excellent way to force a tardy plantation, and that very often it catches up and sometimes outgrows canes planted a few months previously.

"The effect of molasses is very marked, particularly with plant canes, but seems still to act on the ratoons as well . . ."
—[EDITOR.]

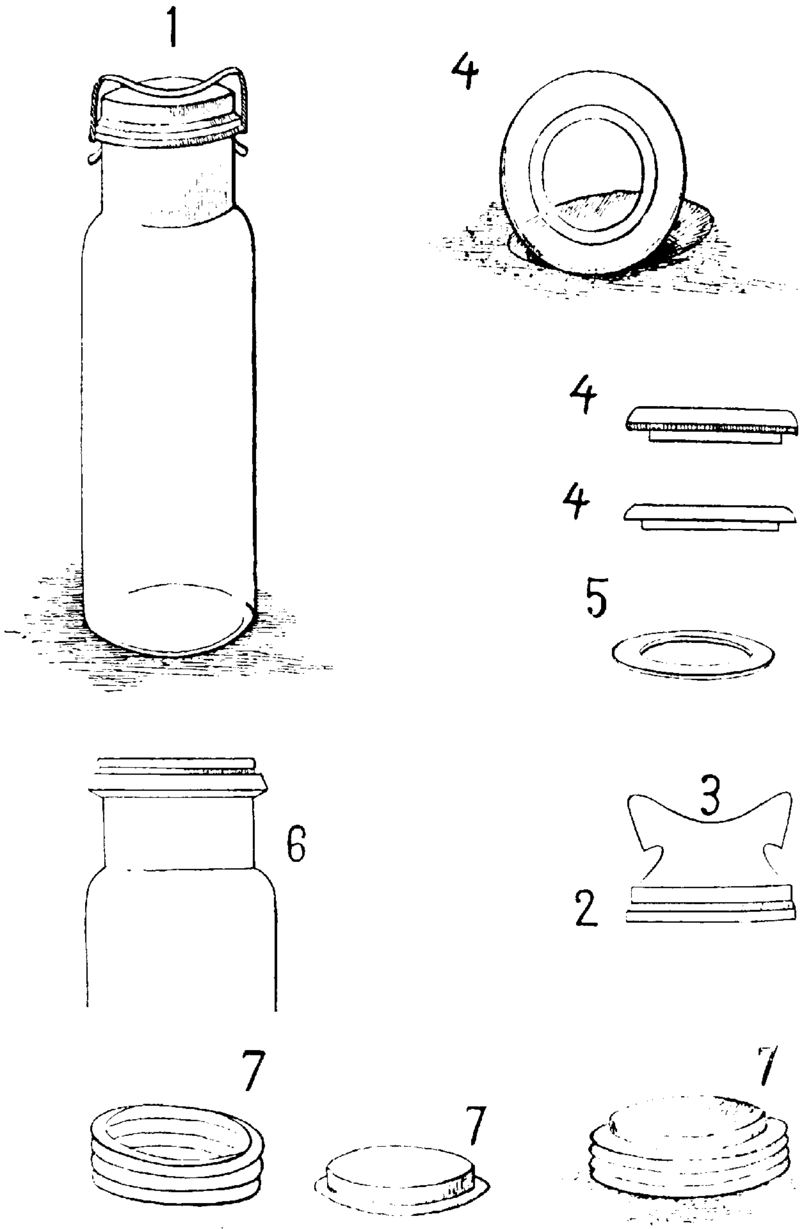
FRUIT BOTTLING.—In an article of the March number of the *Journal of the Board of Agriculture*, Mr. J. Udale, Instructor in Horticulture, Worcester County Council, gives the following interesting account of the preservation of fruit by bottling:—

Though the method of preserving fresh fruit by the process of bottling has been practised for several generations, it is not yet so common as it deserves to be. There are two reasons for this. Firstly, the process is considered to be difficult, and secondly, there is a general impression that a special and costly apparatus for sterilisation is absolutely necessary.

With regard to the first point, it is only necessary to say that in domestic work there are few tasks more simple or easy to perform, and any ordinary intelligent person may successfully bottle fruit. As to the second point, a patent steriliser is not necessary, and the writer, who commenced bottling fruit in 1903, has never used one. All that is really required is a large saucepan, fish-kettle, or some similar vessel in which water can be heated.

Bottles.—These may be obtained specially made for the purpose, through almost any ironmonger, at from three shillings to six shillings and six pence per dozen complete, the price varying with the size and quality of the bottle. Many persons have a decided preference for bottles with glass tops, instead of metal tops, and some like the "screw" tops; whilst others prefer the bottles in which the tops, covers, or discs are held in position by "spring" clips. When counting the cost of the process of bottling, it is well to remember that the same bottles, when once obtained, may be used repeatedly until broken, the chief renewals required being rubber rings, which are used with bottles for rendering them air-tight.

It is absolutely essential that the bottles should be air-tight. An imperfectly-fitting rubber ring or cover will be sufficient to cause failure after perfect sterilisation: the rings and covers must, therefore, fit perfectly. As this cannot always be guaranteed, there will be an occasional bottle which will not be successful. This should be used at once, or the contents emptied into a new bottle and resterilised.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Fruit suitable for preserving.—Any fruit may be preserved by the bottling process, either whole or sliced.

Apples, pears, apricots, peaches, limes, shaddocks and lemons may all be used, though the bulk of bottled fruits consists of plums, gooseberries, cherries, raspberries, loganberries, and currants. Plums and gooseberries are probably the fruits most largely used. When once properly sterilised, and the bottles are quite air-tight, the fruit will keep for an indefinite period. The writer bottled some plums, gooseberries, raspberries, blackberries, and currants in 1903, and they are quite good at the present time.

The Use of Syrup.—Syrup is not necessary, though many persons think it is: pure water is as suitable as syrup, and being more transparent, adds to the beauty of the fruit after sterilisation. Moreover, a thin syrup spoils the natural flavour of the fruit without making it sufficiently sweet to render further sweetening unnecessary when used. Sugar, therefore, should either not be used at all, or it should be used at the rate of half a pound (and upwards) to one quart of water. Raw sugar should not be employed, as it renders the syrup "cloudy:" white lump sugar, however, leaves it tolerably clear.

Ripeness of the Fruit.—The degree of ripeness has a considerable effect on the appearance of the fruit after the bottling process is completed. Fruit should be slightly under-ripe for bottling, as the skin does not then so readily break during the process of sterilisation: with ripe fruit this can hardly fail to happen and the appearance is apt to be spoiled. In this respect under-ripe fruit will bear a higher temperature without injury than the ripe fruit; but in no case need the temperature of the water in the kettle rise higher than 200° F., and in practically all cases 190° F. is sufficient. A thermometer is required to ascertain the temperature of the water.

Quality of the Fruit.—The fruit should be sound and without speck or injury of any kind. It is best gathered dry: but if it be damp or wet, it should be sterilised a little longer. All stalks and large calyces, as in the case of the gooseberry, should be

removed, and fruit of equal size should be placed in the same bottle. Mixed fruit, large and small sizes together in the same bottle, does not sterilise well, and has not a good appearance.

Filling the Bottles.—This is an important operation, as, if the bottles are imperfectly filled, the fruit after sterilisation will rise, and leave a large space at the bottom without fruit. Many have experienced this in their first attempts at fruit bottling. A stout stick or piece of wood, about twelve inches in length—blunt at one end and rather pointed at the other—is very useful in arranging and gently pressing fruit into position in regular layers. The fruit should be selected of nearly equal size and then arranged in the bottle systematically, the fruit being pressed into place by means of the stick when necessary. The bottle should be filled to the top of the neck, still using a little force in packing if requisite.

As the fruit is placed in the bottles, these may be filled up to within half an inch of the rim with clear water, or syrup made by dissolving half a pound of loaf sugar in one quart of water, when they will be ready for sterilising. In the case of bottles with screw caps, the latter may be placed on loosely and partly screwed down in order that they may be readily screwed down tightly directly the sterilising process is completed. In the case of bottles with caps (either glass or metal) and springs, those requiring rubber rings should have the rings softened in hot water, the cap placed on, and the spring fixed in position.

Sterilisation.—In the case of a patent steriliser the subsequent operations will vary with the kind of apparatus; but if the homely fish-kettle is used, it should be deep enough to take the bottles up to the shoulder in water. A board about one-half or three-quarters of an inch thick should be placed at the bottom of the kettle to prevent the bottles coming into direct contact with the kettle, and so causing their breakage, and a little hay should also be placed between the bottles to prevent fracture. In the absence of hay three or four folds of paper may be placed round each bottle. It is important to remember that there is

a difference in temperature between the water in the kettle and the liquid in the bottles; if the temperature of the water has been raised rapidly, there may be as great a difference as 40° or 50° F. The temperature both of the water and of the liquid in the bottles should, therefore, be raised slowly rather than rapidly to the desired maximum.

The caps, rubbers and springs, and screw-tops, having been placed in position, the bottles should be covered in cold water up to the shoulder, and the kettle placed over the fire or gas, and gradually brought to a temperature of from 165° to 190° F. The temperature necessary will vary with the kind and ripeness of the fruit: but a lower temperature than 165° F. is quite unreliable, and a higher than 190° F. or 200° F. is unnecessary.

Immediately the highest temperature has been attained, the kettle may be partly withdrawn from the fire, and the screw-caps should be screwed down as far as they will safely go. The temperature should then be maintained for fifteen or twenty minutes at about 165° F. in the case of small fruits such as gooseberries, currants, cherries and raspberries, and at any temperature between 165° F. and 190° F. for plums, apricots, peaches, and pears. In the case of the latter, forty minutes at a temperature of about 165° F. to 170° F. will answer.

Screwing down the caps.—When screw-caps are used it is most important to keep screwing them down tightly as the bottles cool and contract; the slightest access of air to the interior of the bottle may nullify the work, therefore this kind of bottle requires constant attention during the cooling process, and the tops must be constantly screwed down until contraction is completed.

Experiments.—As a result of experiments with plums sterilised in screw-top bottles in 1908, at various temperatures, it was found that sterilisation at 165° F. to 170° F. for ten minutes produced more satisfactory results than sterilisation at 190° to 200° F. respectively; and samples are as beautiful in December, 1910, as they were immediately after bottling.

Function of Scents, etc., in Plants.—In the Annual Report for 1910 on the Progress of Chemistry, issued by the Chemical Society, the Agricultural Chemistry Section has again been written by Mr. A. D. Hall, F.R.S. He classes as one of the most suggestive papers of the year that published by H. E. & E. F. Armstrong on the action of chloroform and similar substances in stimulating enzyme action in living structures. The Armstrongs, using Guignard's method, show that by placing a leaf of cherry laurel in a test tube together with a drop of chloroform, hydrocyanic acid is given off in a few minutes from the cyanogenetic glucoside contained in the leaf. Vapours of ammonia, carbon disulphide, toluene, ether and various alcohols also, have the same effect and certain other substances have a similar but less effect. Guignard states that the effect of these substances is probably to induce the glucoside to travel to the enzyme by causing changes in the concentration of the cell sap. Carbon dioxide can also produce the same effect to a small extent. This slight initial excitation may be sufficient to set in motion considerable change because the hydrocyanic acid and benzaldehyde thus produced would extend the action.

Mr. Hall thinks that from these experiments light will eventually be thrown on the physiological function of many of the ethereal oils, terpenes and scents which are secreted by plants so normally that they cannot be without significance. They also throw light on the horticultural practice which has been worked out in recent years by which plants like lilacs intended for forcing are exposed to the vapour of ether for twenty-four hours or so. After this process it is found that the plants can be forced into bloom a week or ten days earlier than would otherwise have been possible. As cold acts in the same way by altering the concentration of the cell sap, we may also correlate the similar acceleration of flowering that is induced by a preliminary cold storage before forcing, and again the well-known fact that potatoes which have been frozen become sweet through an accumulation of enzyme-produced sugar.

A. E. Vinson shews that dates which have reached a certain stage of development can be made to ripen by exposure to certain vapours or solutions, practically the same substances which the Armstrongs have found to be active.—(H. E. Annett.)

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Value of Different Crops for Green Manuring.—In the *Journal of the Board of Agriculture* for March 1911, Mr. A. D. Hall has an article under the above title.

At Woburn where the soil is light and dry, it will be remembered that mustard turned under has been found a better preparation for wheat than vetches. At Rothamsted, however, where the soil is heavier and cooler than at Woburn opposite results were obtained in 1907. Further experiments carried out in 1910 at Rothamsted confirm the 1907 results.

The following table shews the yield of wheat per acre after green manuring, in Little Hoos field, Rothamsted :—

Year.	Previous green crop.	Dressed grain.	Dressed grain.	Offal grain.	Total grain.	Straw.
		bushels.	lbs.	lbs.	lbs.	cwt.
1907	After mustard	29·9	1,923	96	2,019	22·5
	" rape	21·3	1,376	75	1,451	29·6
	" crimson clover	32·5	2,096	294	2,390	36·1
	" vetches	39·7	2,542	210	2,752	39·4
1910	After mustard	19·6	1,247	34	1,281	15·3
	" rape	20·8	1,327	37	1,364	16·3
	" crimson clover	30·8	1,926	85	2,011	27·0
	" vetches	34·4	2,144	127	2,271	34·7

Voelcker says that the Woburn results are a matter of moisture; the land being left drier after the vetches than after the mustard, as the former was much the heavier crop.

Hall says that it is not safe to assume that the amount of nitrogen and the water-supply are the only factors concerned in the above results, but the process of decay of the plant residues in the two soils may be different and one is quite ignorant of the possible influence of the intermediate products upon the growing plant. (H. E. Annett.)

NOTE ON "WORK DONE BY THE AFRICAN ENTOMOLOGICAL RESEARCH COMMITTEE."—The African Entomological Research Committee was appointed in June 1909 by Lord Crewe, the then Secretary of State for the Colonies, to promote the study of the insects which play so prominent a part in the spread of disease among men, animals and plants in Africa. Satisfactory progress has already been made and the collections of insects received from Africa after being properly identified and recorded, are being distributed to the schools of Tropical Medicine, Universities, Museums and other Institutions where they are likely to be of value for the purpose of teaching or scientific study. Two skilled Entomologists are being employed under the direction of the Committee in East and West Africa, respectively, for the purpose of interesting and instructing the local officials in the work and also of carrying out special investigations. With a view to further the work of the Committee, Mr. Andrew Carnegie has been pleased to place at its disposal a sum of £1,000 per annum for a term of three years to defray the cost of sending a few suitably qualified young men to the United States to study the practical applications of entomology in that country. The scheme is likely to be of great value to British Administration in Africa and elsewhere by providing a body of well-trained Entomologists available for employment in the services of the different Colonial Governments. The Committee issues quarterly a Scientific Journal entitled the "Bulletin of Entomological Research" which has been noticed in Part 2, Vol. VI of the Agricultural Journal of India.

With a view to stimulate interest in, and to provide facilities for, the study of entomology, the Imperial College of Science and Technology, London, has now inaugurated courses of lectures. In a speech made at the opening of these lectures Lord Cromer, who is the President of the Committee, alluded to the existing need in England of practical field training in the methods of combating insect pests of all kinds. He referred in very appreciative terms to Mr. H. Maxwell-Lefroy, Imperial Entomologist to the Government of India, who during his leave in England has

been engaged to deliver a course of lectures on applied entomology. In his inaugural lecture Mr. Lefroy dwelt on the application of the science of entomology to agriculture, commerce, medicine and sanitation. He pointed out that applied entomology is a development of pure entomology and that this development has only recently been stimulated by the immense importance of tropical entomology. He added that the economic significance of insects rested not merely on their destructive habits but also on their yielding useful products like bees-wax, honey, shellac, silk, etc. There was thus a large field for research and useful work. He then went on to describe the losses caused to cultivators by the insect pests of cotton and cited the instances of Sind and the Punjab where the introduction of a parasite of the cotton boll-worm did an immense amount of good. Reference was made to the ravages of white-ants on railway sleepers, and weevil in wheat and rice in hot countries. Mr. Lefroy stated that in India the loss in wheat from the weevil amounts to over a million pounds sterling annually and in rice to probably three times that on the average. He laid stress on the fact that these losses are preventible and that remedial action must be founded on and guided by scientific entomology, *i.e.*, on an accurate knowledge of the lives and ways of insects causing the losses. He quoted the instances of the successful fighting of the migratory locusts of North India and the Bombay locusts; and also the checking of the potato moth by simple means within the reach of the cultivator. He alluded to the great importance of teaching farmers about their pests by means of lectures, leaflets and coloured illustrations giving them reliable information about remedies and insecticides. He then referred to the significance of insects as carriers of disease to men and to domestic animals and cited the examples of malaria, yellow fever, filariasis, bubonic plague and sleeping sickness which are all insect-borne diseases and emphasised the necessity of developing scientific and preventive entomology. (EDITOR.)

REVIEWS.

Alkali Land. Two Bulletins dealing with the subject of the reclamation of Alkali Land have been recently issued by the Bombay Agricultural Department. The one, entitled "The Salt Lands of the Nira Valley," No. 39, by Messrs. Mann and Tamhane, has reference to some salty land in the Deccan within the area irrigated by the Nira canal. This area has been the subject of examination on several occasions: by the late Mr. E. C. Ozanne in the eighties, Dr. Leather in 1893, by a committee of agricultural and irrigation officers in 1903, and recently by the authors of the Bulletin. The immediate cause of the trouble is the canal which has caused much water-logging: but, as in all similar cases, the damage done is small compared with the advantages gained. It is, as a matter of fact, very much the worst case of damage due to a canal which is known in India: about 12 per cent. of this irrigated area has become more or less saline, and there is some evidence that the affected area is slowly increasing.

The salts present in this land include for the most part sodium sulphate and chloride, and magnesium sulphate and the land would fall under the American definition of "white alkali." As regards the origin of the salt now present in the land, the chemical examination of the river and canal waters goes to show that these are very soft and relatively pure waters, and it is concluded that the salts are largely derived from the soil.

Experiments have been made on the reclamation of some of this land at Pandhara, and these have resulted in showing that by making *open* drains 2′ 6″ deep, or such drains filled with *babul* branches, at intervals of 10ft. from one another, across the

natural drainage line, and which drains empty into major drains which run in natural lines of drainage, the land under the Nira canal, when seriously affected by salts, may be reclaimed in a very short time. The cost of drains at such short intervals is naturally high; those made by the Agricultural Department amounted to about Rs. 250 per acre, but, as the authors point out, the cost would be considerably less.

The authors make one statement which is an obvious mistake. They say "Drains running *in the direction* of the natural drainage of the land . . are of little use . . . ." It is however certain that no system of drains which only ran across the lines of natural drainage could possibly be effective either in the Deccan or elsewhere, and as a matter of fact the system of drains actually employed in the experiments included (a) minor drains, running across the direction of natural flow, and (b) a major drain, running *in* the direction of natural flow, into which the minor drains emptied. This reclamation work must be of considerable value, and subsequent reports respecting it will be of interest.

The bulletin includes much interesting and useful information regarding the nature and quantity of the salts in the soil and in the drainage waters which cannot readily be condensed here.

The second Bulletin on the subject of alkali land, No. 35, entitled "Kalar in Sind," by G. S. Henderson, refers to experiments on the reclamation of the alkali land in Sind. In order to understand the subject, reference is necessary to the Annual Reports of the Daulatpur Reclamation Station, 1907-09. A block of 400 acres of Kalar (alkali) land has been taken up with the object of demonstrating the value of irrigation combined with a system of open drains in such land. The principle involved is of course the washing out of the salts from the soil in part down below the root-range, in part into the system of open drains. Rice followed by cotton and Egyptian clover "Berseem" have been the principal crops cultivated, and Mr. Henderson considered that as a result of 16 months' work, 200 out of the 400

acres are "sweet." The cost of the work has been Rs. 40 per acre. Incidentally Mr. Henderson expresses the opinion that the assistance of a chemist in relation to such work is not necessary. As a matter of fact, it is only after a consultation of Mr. Meggitt's analyses of the Daulatpore soil, that a correct appreciation of the nature of the sort of "Kalar" which is being reclaimed *is* possible. These analyses show that the land contains a variety of salts, chief amongst which is sodium chloride, "common salt," which is present to the extent of ·1 up to 3·0 ; (in about half the samples the amount was less than ·5) and that sodium carbonate is absent. Moreover, the nature of the salts demonstrates that the land at Daulatpore is freely permeable to water and the salts can therefore be readily washed out. This is by no means always the case in "Alkali" land: on this account drainage has often been found useless for the reclamation of such land.—(J. W. LEATHER.)

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"THE MANURING OF MARKET GARDEN CROPS." By Dyer and Shrivell (Vinton & Co. Price 1/-). We have received a copy of this small book which has been written for the advantage of market gardeners in Great Britain, but which would probably be of interest also to gardeners in India. Sixteen years ago it was decided to start experiments on the value of artificial manures for vegetables. The universal custom had been to use only farm and stable manure, which were, and are still, used in quantities aggregating some 25 tons or more per acre per annum, the cost of which is estimated at between £10 and £20 per acre. In comparison with such quantities of manure, phosphates, chili saltpetre and potash salts have been used, and the result shows that for a majority of crops, mixtures of these artificials either alone or in combination with half the usual amount of farm manure may be used with advantage. The outturn is quite maintained and often increased. The cost of the artificials or artificials plus farm manure has been from £3 to £6 per acre.—(J. W. LEATHER.)

REPORT ON THE PRESENT POSITION OF COTTON CULTIVATION PRESENTED TO THE INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE, BRUSSELS, MAY 1910. By Prof. Wyndham R. Dunstan, M.A., LL.D., F.R.S., published by the International Association of Tropical Agriculture and Colonial Development, British Section, Imperial Institute, London, S.W. Price 1/-.—This report is a résumé of the utmost value, of the information which was supplied from many parts of the cotton-growing world. As it is the first publication of the kind furnishing us with a record of what is being done with cotton wherever it grows, it deserves a more detailed notice than is usually considered necessary in a review. The publication of the complete reports is promised later on, but the general public will probably rest contented with the present summary which provides all the information actually required. The author points out that Europe is still entirely dependent upon the U. S. A. and in a lesser degree on Egypt for its cotton supply, and any sudden shortage or falling-off in quality in this leads not only to the dislocation of the Industry but in consequence, also to many trade complications. From the United States of America, which is fortunate enough to possess the best equipped and most efficient of the agricultural departments in existence, we have an exhaustive and admirable statement of its cotton-growing industry which is the greatest in the world. There is said to be still a vast amount of land which could be rendered suitable for cotton cultivation, and it is thought that sufficient cotton could be produced in the U. S. A. to meet the increasing demand for at least another generation.

The Department of Agriculture is making efforts to obtain improved and early maturing types and also varieties resistant to certain pests. Careful experiments are in progress to determine the most suitable manures for particular soils and effect of the manurial constituents on the yield of lint and the quantity of oil in the seed. Efforts are also made to improve the farmer's knowledge of the best methods of preparing the soil, cultivation, seed selection and rotation of crops. As we find in India, the

maintenance of quality of the good types of cotton at present grown depends very largely on the efforts of the individual farmer.

In Egypt, which ranks second as a centre of production, we have also an interesting report from the Khedival Agricultural Society, under which much valuable scientific work in cotton cultivation is now being done.

The outlook is not satisfactory. There has been a serious decrease in the average yield per acre and also in the quality of the cotton produced.

During the last ten years there has been a decrease of 26 per cent. in the average yield per acre and the decrease has been continuous during the period.

The precise reason for this is not easy to ascertain. Various authorities attribute it to the ravages of the cotton worm and cotton boll-worm; others to the absence of seed selection; others again to the exhaustion of the soil following the custom of growing cotton in rotation biennially instead of triennially as was formerly the case. The problem of arresting the boll-worm has been successfully solved in the United States and should present no great difficulty in Egypt. Recorded evidence goes to prove that seed selection *is* carefully conducted. The most probable cause which has so far been suggested is that the deterioration is caused by over-watering, as so much more water has become available to the cultivators since the construction of the Assuan Dam and the barrages on the Nile. The whole matter is to be investigated by a Committee to which the scientific officers of the Agricultural Society are to be attached.

The Egyptian Government has now established an Agricultural Department. Had this step been taken before, the exact reasons for the present deterioration in the Egyptian crop would, perhaps, have been already determined.

The problem of the extension of the existing cotton area in British, French and German West Africa is very important and it is one which presents the difficulty we have in India, namely,

that the views and needs of a large population with conservative ideas must be taken into account. The only solution of the difficulty of course lies in the creation of Agricultural Departments which will demonstrate the introduction of superior varieties with the necessary methods of cultivation required by them. Much can be done also by a system of buying agencies which will ensure the cultivator getting a fair price for a superior product. The chief scientific problem to be solved in West Africa is that of establishing a type of cotton suitable to the country and the European spinner. The acclimatised types, as in India, may be greatly improved by selection and systematic hybridisation. Accounts of such work already in hand are given from various countries.

In Uganda and Nyasaland an acclimatised cotton of American Upland long-stapled type is being gradually and satisfactorily evolved as the established cotton. Favourable views are expressed as to the prospects of Sea Island cotton in several other countries: Sea Island, however, gives a smaller yield than other cottons, it is more difficult to acclimatise and requires greater care in cultivation. It is also specially sensitive to climatic changes and is particularly subject to the attacks of insects. It, however, offers splendid opportunities for successful hybridisation with inferior cottons with a view to the production of an improved acclimatised type suitable for European spinning.

In India, hasty attempts to introduce exotic cottons are doomed to failure. Experiments, which are being taken up, will assist to determine whether it will be profitable or not to introduce some of these into tracts beyond the recognised cotton-growing areas.

China stands next to India in point of production and it grows a coarse, short-stapled cotton of Indian type. It appears that the cultivation is extending and India may, in the near future, suffer from a decreased demand for the inferior cotton which she at present exports to China and Japan.

The author insists on the vital importance of the establishment and maintenance of efficient agricultural departments in

the countries in which cotton production is important. He cites evidence to prove how the application of the knowledge of Entomology, for instance, has been successful in helping the farmer to cope with the boll-weevil, the most serious of all cotton pests. Investigations also into the life-history of the boll-worm in the United States and Egypt have indicated the steps necessary to destroy this insect.

In the second part of the report the author gives summaries of reports on cotton cultivation. The writers of these reports were requested to pay special attention to the following points :—

(1) the present position and prospects of the industry ;

(2) any special difficulties met with ;

(3) nature of experimental work in progress.

In addition to the special reports which have been obtained accounts of countries from which no special reports were received have been prepared at the Imperial Institute. The whole section will repay careful perusal by those interested in the subject of cotton cultivation, as it gives the latest information compiled under these three heads from practically every cotton centre in the world.

The following are some of the deductions which can be safely drawn from a careful study of this summary :—

1. There is a general eagerness to profit by the experience gained in other countries, notably so in the U. S. A.

2. That the areas most suitable for the production of superior or standard varieties have been taken up and that other areas often of enormous extent which may ultimately prove to be equally suitable are debarred for the present by scarcity of labour, difficulty of transport, or competition with more remunerative crops or with crops more suited to the genius of the people. On the whole, the most certain methods of improvements are attained by selection of seed from the varieties already established in the particular tracts as varieties foreign to the soil are more susceptible to changes of climate and the attacks of pests.—(G. A. GAMMIE.)

A GLUCOSIDE FROM TEPHROSIA PURPUREA.—A Paper bearing the above title appeared in the September (1910) number of the Journal of the Chemical Society. The authors are Messrs. G. Clarke and Shrish Chandra Banerjee of the United Provinces Department of Agriculture. Tephrosia purpurea, known in the vernacular as "Jungli Nil," is common in many parts of India and especially in the United Provinces where it is often a bad weed. The work was begun in India and finished in England by Mr. Clarke at the Davy Faraday Laboratory of the Royal Institution, London. The authors show that the leaves of the plant contain about $2\frac{1}{2}$ per cent. of their dry weight of a glucoside which they isolated and examined.

On hydrolysis this glucoside gave rise to two sugars which were recognised as rhamnose and dextrose respectively and also to a yellow crystalline substance. This latter was, from its properties and from analyses of its derivatives, shewn to be quercetin.

Quercetin is a substance for which there is a commercial demand as it is used to a considerable extent in the dyeing industry. The plant does not contain indican or other substance yielding indigo.—(H. E. ANNETT.)

* *

"CANE SUGAR" BY NOEL DEERR.—The attention given in recent years to sugar production from both the Chemical and Biological sides has resulted in a large amount of work which has modified many of our theories concerning the culture of sugar-cane and the manufacture of sugar. The literature of this subject is now extensive and it is beyond possibility for many of those engaged in sugar laboratories and factories, very often in remote corners of the world, to have access to more than a very small portion of it.

In "Cane Sugar" by Noel Deerr the reader is able to obtain an excellent general idea of the lines upon which recent work has proceeded and their practical application, as well as the methods of manufacture used in up-to-date factories. The author is well known as a Sugar Technologist and his experience in countries of

widely variant character has given him a broad view of the salient points of the industry.

Nowhere more than in India has the need been felt for a book of this kind, but it must be a matter of some regret to Indian readers that this country growing over two million acres annually comes in for such a small share of attention. It is a striking reminder of the undeveloped state of the industry, but it is hoped that material may be forthcoming to remedy this defect in future editions.

The arrangement of the book is good, but as the author has given considerable space to the botany and pathology of the cane, a chapter might very well be added, giving a more detailed account of the work that has been done on the improvement of the varieties of cane by cross-fertilization and selection, instead of dividing it into paragraphs on "Sports" and "Seedling Canes" in Chapter IV under the heading of "Varieties of Cane" and a paragraph on "Chemical Selection" in Chapter VIII under "Husbandry."

The subject is of immense importance to the industry and much time has been devoted to it by the experts in Java and the West Indies, notably in the former country where the literature in the Dutch language is not easily accessible to English readers.

In the Chapter on Sugar-cane Soils (Chapter V), the chemical analyses of typical soils of some cane districts are given and critically discussed. It is pointed out that the water-retaining power of the soil and other factors depending on the mechanical condition are of first importance, but only one incomplete example is given of the mechanical composition, although this is known to afford equal if not more valuable information than chemical analysis by the older methods.

There is abundance of material in the literature for the chapter on the "Manuring of the cane" (Chapter VI) and the author is to be congratulated on the manner in which he has placed it before his readers. This chapter which contains a detailed description of the important experiments carried out in the West Indies under the auspices of the Imperial Department

of Agriculture, will prove one of the most valuable to East Indian readers where the subject of manuring is becoming more discussed every year.

It is interesting to note that the West Indian workers, as the result of many years' experiments, have apparently succeeded in standardising, as far as the soils of those Islands are concerned, the empirical citric acid method of Dyer of determining the available plant food (page 58).

The statement on page 71 that "nitrification is essential to the assimilation of nitrogen by plants must now be abandoned," in the paragraph dealing with the choice of nitrogenous manures, might lead the reader to believe that it is no longer considered necessary to promote nitrification by suitable cultivation. Although it has been demonstrated that plants can assimilate ammonia under special conditions and use it to build up their protein molecule, it is still a fact that crops thrive best on soils where nitrification is active.

The paragraph on "Bacteria in relation to the Soil" in the same chapter contains no reference to the very important researches of Russell and his co-workers at Rothamsted on the bacterial flora of the soil.

India has got a great deal to learn from other countries about irrigation, and the Indian ryot is a master in the art of conserving soil moisture. The chapter on this and the husbandry of the cane, which refers exclusively to the cultivation of the varieties we call "Paunda" in this country are perhaps not of such general interest as the rest of the book to the average Indian reader who grows for the production of sugar the thin "Ukh" and "Ganna" varieties which demand quite different treatment.

These chapters, however, contain some interesting information and figures on the yield of sugar and on the methods used in different parts of the world, and we, in this country, compare with astonishment the 20,000 lbs. of sugar per acre of the Hawaiian Islands to the 2,000 to 3,000 lbs. we are accustomed to here.

The latter part of the book deals with the factory and a chapter is devoted to the discussion of each process. Chapter XI

deals with the extraction of juice by the mills, and the important question of increasing the total extraction of sugar by the various methods of saturation are worked out. There is a misprint in the formula on page 208. As it stands, it is equal to one. It should be $\frac{m.(f+wm)-fm}{m.(f+wm-fm)}$.

In this country where the cultivated canes carry a high percentage of fibre, the question of increasing the total extraction of sugar by saturation is a very important one. There is no doubt that the single dry crushing of the "Ukh" and "Ganna" canes, as almost universally practised in India, leaves considerably more recoverable sugar in the canes than is generally thought to be the case. No advantage is gained, as far as actual extraction of sugar is considered, by replacing the three roller bullock mill by the smaller type of steam-driven mills, unless saturation in some form is provided for.

The concluding chapters on evaporation, concentration and the final processes in the production of the different grades of sugar are well put together: and the chapters dealing with laboratory work contain a full description of all the modern methods of analysis.

The diction is at times a little strained, for instance the terms "haliophile" and "calciophile" might with advantage be replaced by more work-a-day expressions, but as it stands, the book will be a valuable addition to the library of the up-to-date sugar factory and plantation. —(G. CLARKE.)

THE OFFICIAL TEXT BOOK OF EGYPTIAN AGRICULTURE is now completed by the recent issue of Vol. II. The Editors are Messrs. G. P. Foaden, Secretary, General Khedival Agricultural Society, and F. Fletcher, recently Principal, School of Agriculture, Giza, and before that Deputy Director of Agriculture, Bombay Presidency. Vol. I contains preliminary articles on Soils and Manures, etc., and three valuable contributions by R. Lang Anderson, Director of the Aboukir Reclamation Company, Alexandria

He is head of the company which has successfully reclaimed the site of the old salt lake of Aboukir. These comprise Irrigation and Drainage, Farm implements of Irrigation and Land Reclamation. It is on a system similar to that outlined in this latter article that the Doulatpur Reclamation Farm in Sind is based.

The second and final volume consists of articles on farm crops, rotations, fruit and vegetables, farm pests and farm live-stock. The chief article in the book is that on cotton by Mr. G. P. Foaden.

In Egypt the annual production of cotton is about 1/10th that of the United States and about ½ the average Indian crop. The yield per acre is high, but for various reasons is steadily diminishing, being about 400lbs. lint cotton per acre. This compares with an average of 200lbs. in the United States and less than 100lbs. in India. The Agricultural position of Egypt and the prosperity of the Egyptian cultivator is based on the quality of the fibre produced: the production of high grade cotton has been in the past almost an Egyptian monopoly.

Mit-Afifi or Egyptian brown, forms the great bulk of the crop and is hardier than Abassi which is the only white cotton grown in Egypt. In general the 'fellah' takes the greatest care over his cotton, the land is ploughed and ridged after berseem, sown by hand, thinned and constantly hoed till the plants meet in the row. In the south it comes every three years in the rotation, but on the coastal lands of the north it comes every second year.

Among the cereals maize is the chief hot weather crop with a smaller area of sorghum. Rice is cultivated in the salt lands of the Delta, also a 60-day variety is used to "sweeten" the ground and is often grown as a catch crop between the main cold weather and hot weather crops. Wheat, beans and barley are the cold weather grain crops. In Upper Egypt these crops are grown on the 'basins' (*i.e.*, large 'bunded' areas of land flooded on the rise of the Nile), the seed being often broadcasted in the wet 'gup' when the river goes down. 'Tibn' or chopped

wheat (and to less extent barley) straw is almost as valuable as the grain; it is the universal fodder for all animals in Egypt in the hot weather and often sells at £1 per camel load.

Sugarcane is grown in some districts of Upper Egypt and a little in Lower Egypt; it takes the place of cotton and is generally grown under the encouragement of one of the large sugar making companies to whom the cultivators sell their canes.

There is a large area under garden and fruit and vegetables; the latter consist largely of cucurbits and onions. Fruit culture is poor except grapes and dates.

The other crops are of minor importance except berseem (Trifolium alexandrium). This is the backbone of Egyptian agriculture and it renders possible the intensive cultivation practised, where crop follows crop in endless succession. It practically forms the sole food of all live-stock from November to June. Out of 5 million acres of cultivated ground in Egypt $1\frac{1}{2}$ millions are sown down to berseem each year. It is far superior to lucerne for the cultivators' purpose for the following reasons:—

1. It is purely a cold weather rotation crop and does not take the place of any money-making crop.

2. Will give three cuttings before the first cut of lucerne could be taken.

3. It will grow on salt land if plenty of water and drainage is available.

Four varieties are mentioned in the book, but the basin berseems are looked on more or less as weeds in Lower Egypt. Seed for use in India should be obtained from the salt lands of the extreme north.

A section is contributed by Mr. J. S. J. McCall on farm animals. Work cattle as compared with many Indian breeds are mixed and patchy and show no signs of any fixed breed. They are often of good size but are very expensive; £20 is common for a good bullock.

The article on insect pests is interesting. Cotton boll-worm is a terrible scourge and in an average year the loss due to it

approaches a million pounds sterling. The cotton worm which eats the foliage is also a serious pest. It is specially bad in the North where in a bad year as much as half the crop is spoiled. In 1905 cotton-growers were compelled by special legislation to pick off the leaves on which eggs had been laid and to destroy them under pain of a heavy fine. This has resulted in a very general improvement. There are a number of other pests as cotton aphis, cut worm, stainer, weevils and stem borers. Spraying and such methods are not considered feasible on a large scale to combat these pests.

The book on the whole is of great interest to India, especially to the canal-irrigated tracts. Owing to the method of its preparation there is some overlapping and the Editors state that the book is presented as a series of detached contributions for which the writers are personally responsible.—(G. HENDERSON.)

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